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# **Mobile applications as a tool for participatory extension: a case study of the Lima Farmer Support application**

A thesis submitted in partial fulfilment of the requirements for  
the degree of

Master of Commerce (Agricultural)

**at**

**Lincoln University**

**By**

**Ncebakazi Lutuli**

**Abstract of a thesis submitted in partial fulfilment of the requirements for the**

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By

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Traditionally, agricultural extension in South Africa has been quite linear, focused largely on increasing production, improving yields, training farmers and transferring technology. This traditional approach produced poor results for the country's small-scale farmers. Shortcomings in the traditional method have encouraged a shift to more participatory extension methods that involve farmers in the innovation process and recognise local knowledge. The biggest drawback of the participatory extension approach is its cost. However, mobile applications can potentially turn farmers into trainers, improving farmer-farmer knowledge diffusion and reducing extension costs. This research examined user acceptance, facilitating conditions and application characteristics as key factors influencing the use of a mobile application developed by Lima, a non-government rural development organisation based in Pietermaritzburg, South Africa. This investigation was guided by the Unified Theory of Acceptance and Use of Technology (UTAUT), and the application's characteristics were evaluated using an approach that puts 'People at the Centre of Mobile Application Development' (PACMAD). Interviews were conducted with eleven of Lima's facilitators, eleven of their farmer clients, one manager, and two application developers. Information from the interviews was supplemented with direct observation, data generated by the application itself, and document review. NVivo was used to code the data for pattern-matching analysis. Patterns in the data were compared against propositions suggested by the UTAUT model. Where the patterns matched, the propositions were confirmed, where they did not, analysis progressed to explanation and theory building.

This study found that the most critical factors influencing facilitators' acceptance of the application were performance expectancy, facilitating conditions and social influence. Amongst farmers, the key determinants were performance expectancy, facilitating conditions, trust, peer recommendation, and investment priorities. The facilitating conditions most important for farmers were the availability of user-support and access to markets. Prior experience with mobile applications of any sort positively influenced the largest number of factors that directly encouraged the use of Lima's application by facilitators and farmers. The study also found that farmers who engaged in land-intensive enterprises, such as pigs and poultry, were more likely to adopt the application. Relevance, ease of use and the ability to function off-line were the application characteristics that appealed most to both farmers and facilitators. Based on these findings, this study concluded that mobile applications could support participatory extension if they provide relevant services and actionable advice to farmers; are introduced by a reputable organisation and experienced facilitators as part of a broader initiative linking farmers to markets; and if they select master farmers who engage in land-intensive enterprises and who have prior experience with mobile applications.

**Keywords:** Agricultural extension, smallholders, South Africa, technology adoption, UTAUT, mobile application

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## Abbreviations

UTAUT – Unified Theory of Acceptance and Use of Technology

IDT – Innovation Diffusion Theory

TAM – Technology Acceptance Model

PACMAD – People at the Centre of Mobile Application Development

FAO – The Food and Agriculture Organisation

FFS – Farmer Field Schools

FFE – Farmer-to-Farmer Extension

NGO – Non-Government Organisation

ICT – Information and Communication Technology

TRA – Theory of Reasoned Action

TPB – Theory of Planned Behaviour

MPCU – Model of Personal Computer Utilisation

MM – Motivational Model

SCT – Social Cognitive Theory

KZNDARD – KwaZulu-Natal Department of Agriculture and Rural Development

FHAME – Farmers' Hubs Agri-Marketing Enterprise

SFSA – Syngenta Foundation for Sustainable Agriculture

Stats SA – Statistics South Africa

DAFF – Department of Agriculture, Forestry, and Fisheries

NDA – National Department of Agriculture

IFAD – International Fund for Agricultural Development

# 1 Introduction

This chapter presents an overview of South African smallholder agriculture, provides a synopsis of agricultural extension in South Africa, introduces the concept of mobile applications in agricultural extension, and the mobile application being studied. This is followed by the purpose and significance of the thesis and concludes with an outline of the thesis.

## 1.1 Background and overview of smallholder farming in South Africa

South Africa has a dualistic agricultural sector consisting, on the one hand, of a well-integrated, highly capitalised commercial sector with approximately 35 000 white farmers, producing around 95% of the country's agricultural output on 87% of total agricultural land. On the other, the smallholder sector consists of approximately four million black farmers farming in the former homeland areas on 13% of South Africa's agricultural land (Aliber & Hart, 2009). This dualistic nature of the sector is a legacy of apartheid which systematically eroded historically successful land-based production systems and livelihoods of black South Africans leading to patterns of dispossession and impoverishment (Neves & Du Toit, 2013). Three decades after the fall of apartheid, this sector continues to be characterised by inequality regarding the distribution of economic assets, support services, market access, infrastructure and income (Pienaar & Traub, 2015).

The South African government has assigned smallholder agriculture to drive rural development and to improve rural livelihoods, specifically in the former homelands (Pienaar & Traub, 2015). Through the National Development Plan, the government has committed to expanding the number of smallholders selling their produce to 500 000 by 2020 (National Planning Commission, 2011). It is believed that growing farmers' incomes is fundamental to economic and social development and could contribute significantly to reducing rural poverty and unemployment (Von Loeper, Musango, Brent, & Drimie, 2016). There is a growing consensus that improved market access is essential for raising smallholders' agricultural production income (Markelova et al., 2008). However, smallholder farmers in South Africa have been found to face barriers that prevent them from successfully participating in markets (Von Loeper et al., 2016).

According to the International Fund for Agricultural Development (IFAD) (2003), market access has three dimensions: physical access, market structures and producers' lack of skills, information and organisation. Physical access to markets refers to the actual physical components of market access such as transportation and distance. Ortmann and King (2007) found that in the KwaZulu-Natal province of South Africa smallholders used public transportation to reach markets. This form of transport is not always adequate to transport agricultural produce. Homesteads within these areas are geographically dispersed, and residents often walk long distances to reach the nearest road served by public transport. Also, due to the poor quality of the roads, it is often impossible to travel after heavy rains, this puts pressure on farmers who have highly perishable products (Khapayi & Celliers, 2016). Structure of markets refers to the asymmetric relations between farmers, market intermediaries, and consumers. Smallholders have been found to have no formal marketing contracts and to sell only in low volumes. There are high transaction costs to smallholders' production and marketing of otherwise profitable produce (Matungul, Lyne, & Ortmann, 2001). Relations asymmetry is further exacerbated by farmers' lack of information and organisation. Smallholders lack timely access to relevant and precise information on prices, sites of effective demand, preferred quality characteristics of produce, and alternative marketing channels. Due to their scale, lack of information and lack of collective action South African smallholders often resort to selling to buyers of convenience, usually at an unfavourable price (Magingxa, Alemu, & Van Schalkwyk, 2009).

Beyond the issues cited by the IFAD, literature often cites access to credit, availability of extension services, level of organisation, relevant training, and the farmers' socioeconomic conditions as determinants of smallholders' access to markets (Aliber & Hall, 2012; Von Loeper et al., 2016; Ortmann & King, 2007). Ortmann and King summarise the challenges facing smallholders in South Africa as being: low education levels; insecure land tenure; high transaction costs; lack of credit and insurance access; lack of access to input services; lack of access to markets; lack of access to technology and missing support systems such as well-functioning cooperatives. Some of these challenges can be addressed through the efficient implementation of appropriate extension approaches (van den Ban & Hawkins, 1996; Akinagbe & Ajayi, 2010).

## 1.2 Agricultural extension in South Africa

Agricultural extension services in South Africa can be traced back to 1902 when scientists were brought in from England to assist in the development of agriculture in the country. Due to their lack of familiarity with local conditions, the local farmers often found the scientists' advice and recommendations to have no practical value to them. In 1907, the first South African scientists were sent to study abroad so that they could learn improved agricultural practices while being aware of local conditions. In 1914, the sector went through another amendment with the introduction of the concept of farmer demonstration trains. The idea behind the farmer demonstration trains was to have closer and more personal contact with farmers and their problems. The country's Department of Agriculture took this further in 1925 by establishing a separate Division of Extension to link specialist technical services with farmers. This division had six extension officers serving four provinces. The division highlighted the value of an integrated approach to farmer support. The Division of Extension also organised field trials and demonstrations where farmers could see for themselves how crops, pasture, and fertiliser react to the environment, and thus improved the adoption of improved practices (Liebenberg, 2015). Even as the extension services sector continued to evolve, the approach to extension services continued to be predominantly top-down, mainly focusing on technology transfer. South Africa was no anomaly, as at the time, globally, extension services focused only on increasing production, improving yields, training farmers and transferring technology (Davis, 2008).

While progress in the country's extension services was being made, it was not inclusive. The Division of Extension served and supported only the white settlers. Extension to the country's majority black population was developed separately, with different objectives (Coetzee, 1987). In 1905, Teko, the first black agricultural college was opened to cater to the agricultural knowledge needs of the country's black population. However, it was not until May 1962, in a conference in present-day Harare that there was a drive to establish a formal extension service for black farmers. Even so, the services were severely underfunded compared to their white counterparts (Koch & Terblanché, 2013). The homelands era which commenced in 1976 improved agricultural extension for black farmers through the development of homeland

extension services and agricultural development corporations. The development corporations were responsible for the implementation of betterment, while homeland governments focused on providing extension services. The homeland development approach favoured large scale projects which provided management, inputs, tillage, and marketing but were capital intensive and therefore inefficient and failed to produce independent farmers (Liebenberg, 2015).

In 1983 the Development Bank of Southern Africa introduced the Farmer Support programme to replace the large capital-intensive schemes. This programme aimed to promote the integration of agricultural production with other non-farm related rural development initiatives. In 1989 the programme was redefined and began to focus on providing access to support services to farmers. These services included input supply, capital provision, mechanisation, and research and training (Van Rooyen & Nene, 1996). Hayward and Botha (1995), reviewed the Farmer Support Programme and identified a wide range of problems with the extension services:

- They found that in most instances the extension services being rendered were ineffective due to a lack of proper training for extension officers.
- Most research was targeted at the white commercial sector, extension to smallholders was therefore rarely backed by research.
- The programme made use of outdated extension methods.
- Farmer training centres were crowded and inefficient as they were not built for the growing homeland occupancy.
- There was a lack of coordination between the Departments of Agriculture and Agricultural Corporations.

The dawn of a new democratic South Africa in 1994, brought an end to the separatist policies of the Apartheid government. Democracy brought the promise of equality and an end to the dualistic operations in agricultural extension. The National Department of Agriculture (NDA) was established in the 90s in an effort to promote equality within the agriculture sector. The new department integrated the homelands' departments of agriculture with the previously white-



commercial-only national agriculture and extension services. The integration resulted in new policies, provincial departments of agriculture, and, significant cuts in staffing (Liebenberg, 2015).

The merger and integration, with a few alterations along the way, produced the current agricultural public extension services in South Africa. The sector, as it stands today, is riddled with inefficiencies. According to a report by the National Department of Agriculture (2005, as cited in Department of Agriculture, Fisheries and Forestry, 2011, p. 30) into the state of extension and advisory service within the agricultural public service, “the capacity of provinces to deliver quality extension services to farmers varies, and to some, it is already suffocating.” According to Düvel (2002), much like the departments of agriculture of the former homelands, the provincial departments were unable to maintain farmer support services efficiently. In 2010 the NDA reported that South Africa only had a third of the extension officers it needs to meet its development targets. To further aggravate the situation, of these, eight out of ten were found to be insufficiently qualified to hold their positions. As a response to this report, in 2011 the NDA launched a programme called the “Extension Recovery Programme.” The department highlighted five pillars under which the programme should operate: “(1) ensure visibility and accountability of extension; (2) promote professionalism and improve the image of extension; (3) recruit extension personnel; (4) reskill and re-orientate extension workers; and (5) provide ICT infrastructure and other resources” (Liebenberg, 2015, p. 15).

In 2014, the Department of Agriculture, Fisheries, and Forestry (DAFF) reviewed the Extension Recovery Programme and noted that although the number of extension officers on the ground had been increased, the system remained inefficient. Based on this recognition, the department began restructuring the national policy on extension to consider alternative extension methodologies and institutional arrangements (e.g., public-private partnerships) (DAFF, 2014). They put emphasis on a participatory approach to extension and looked to partner with Non-Government Organisations and established agribusinesses to assist in the delivery of extension services. Examples of these partnerships include using agribusinesses to facilitate the input supply, extension provision and mentoring of farmers who have acquired loans through the state-owned Land Bank Retail Emerging Markets scheme, and using NGOs to facilitate state-mandated

interventions such as the Treasury commissioned Jobs Fund. The Jobs Fund is looking to create jobs in the rural areas through agriculture by providing extension service, credit, and market linkages to smallholders through the revamped Farmer Support Programme (Liebenberg, 2015; The Jobs Fund, n.d.). One of the NGOs in partnership with Jobs Fund in the Farmer Support Programme is Lima Rural Development Foundation (Lima).

### 1.3 Lima and the Farmer Support Application

Lima was founded in 1989 as a response to the apparent development needs of people in rural KwaZulu-Natal, South Africa. Over the years, the NGO has grown to serve rural communities across South Africa. Lima uses well-adapted, practical interventions to establish appropriate institutions to improve rural livelihoods, alleviate poverty and build human capacity. One of the field-based interventions Lima is currently running operates on a grant from the Jobs Fund and is called the Smallholder Farmer Support Programme. This programme aims to provide a range of support services to smallholders in rural areas, including technical training on relevant farming best practices; microfinancing; access to good quality, affordable farm inputs and facilitation of entry into markets to improve productivity and ultimately increase income.

The Jobs Fund has set certain key performance indicators (KPI), such as the number of inputs and market linkages the programme has established, to monitor the progress of the programme. Lima briefly reports on these KPIs monthly and then in more detail each quarter. Reporting on the KPIs requires that data be collected by facilitators, who are Lima's field-based extension officers, and then collated by the agricultural managers at the regional and head offices. This task proved to be time-consuming and was prone to inefficiencies as papers containing the necessary data would often get lost. Facilitators were spending copious amounts of time on administrative tasks, and this was detracting from their core work. As a response, Lima commissioned the development of an application to be used on tablets to timeously collect the relevant data as facilitators carry out their extension work. The application and tablets eliminated the double task of first collecting data through an assessment done on paper, transferring it onto a spreadsheet and then filing the assessment sheet under the specific farmer's name to allow for later reference. The application allows facilitators to register farmers and cooperatives into the

programme, to assess the progress of their enterprises, to obtain GPS coordinates of their operation site, and to register job searching farmworkers and link them to farmers who are looking for labourers. The information collected by the application is used to report to JobsFund, to assist facilitators with their activity planning and informs strategies aimed at advancing the programme.

The successful integration of the Lima Farmer Support Application into facilitators' fieldwork has led to a call to introduce an application that can be used by master farmers as part of Lima's agrihub model. Lima's concept of an agrihub is a place where smallholders can access inputs, markets, production services, and technical support within their areas. Crucial to the success of the agrihub is what Lima calls master farmers. Master farmers are chosen from experienced farmers who own tractors and can contract out mechanisation services to other smallholders. As part of the agrihub model, 60 master farmers are contracted to service six to fifteen smallholders within a 20-kilometre radius of the master farmer (Figure 1.1). Lima plans to expand the role of the master farmers beyond providing mechanisation services to include assisting smallholders in their groups with their enterprise and input planning, providing them with primary technical support, and being the link between them and services offered at the agrihub.

Expanding the role of master farmers would require improving their capacity. The master farmer application is one of the suggested ways in which this can be done. Firstly, the proposed master farmer application would allow master farmers to assist their clients with production and input planning, once they have completed the planning the master farmer can use the application to deliver an inputs order to their agrihub. The master farmer can then collect the inputs from the agrihub and deliver them to their clients when they visit the clients' farm to till, spray or perform other mechanised practices. Secondly, the application will allow master farmers to assess the progress of their clients and collect the due diligence Lima requires to offer loans. The master farmer will also serve as a facilitator of the loan repayment as they have social connections with the smallholders they are servicing.

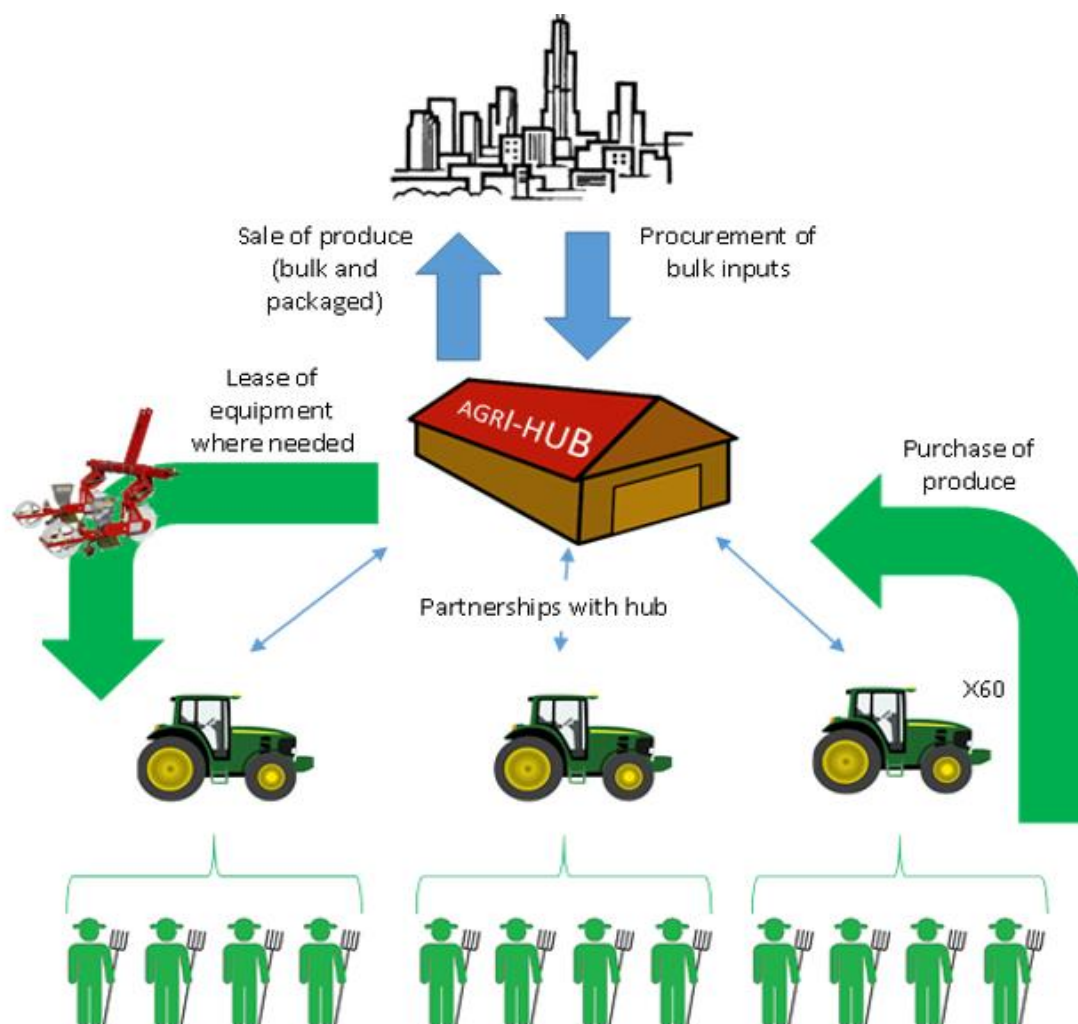


Figure 1.1 Lima Agrihub Model (Flanagan, 2017)

In 2005, the NDA reported that the ratio of extension officers to commercial farmers was 1:21, while that of extension officers to smallholders was 1:857. Having master farmers, with the support of their facilitators and the mobile application, take on some extension duties could improve smallholder access to extension services. The Lima agrihub model, with the mobile application, has the potential to encourage sustainable participatory extension. Having the master farmers, who have the incentive to serve smallholders as paid contractors, delivering some extension services and initiating engagement amongst their clients could lead to a more demand-driven and more sustainable provision of extension services to smallholders.

Beyond the scope of Lima, mobile applications could improve South African agricultural extension delivery through a roll-out of a standardised, well-researched application for extension officers. Providing standardised knowledge across the country would help reduce inequality in the quality of extension service being offered to commercial farmers and smallholders and provide a form of day-to-day training for extension officers to improve their knowledge.

#### 1.4 Purpose and justification of the thesis

While there has recently been an influx of literature on mobile phones in agriculture, there is very little on mobile applications specifically, especially in a South African context. Mobile applications have the potential to revolutionise how we handle and transfer information, a major part of agricultural extension; it is therefore important that an understanding of them is formed so that their potential can be fully harnessed.

This study is expected to contribute to the literature by analysing the factors which affect mobile application adoption in South Africa and investigating the conditions which would lead to mobile applications effectively supporting participatory extension services. The findings of this study will guide the development of Lima's proposed farmers support application and inform policy on mobile applications in agricultural extension. The findings of this study are expected to benefit Lima, policy makers, agribusinesses, application developers and other stakeholders.

#### 1.5 Outline of the thesis

The thesis is divided into five parts. Chapter 2 reviews relevant literature to explain the factors that influence users' adoption of mobile applications, highlights the characteristics of a highly usable mobile application and develops a theoretical framework for investigation. The chapter concludes with the study research objectives and research questions. Chapter 3 describes the research design, justifies the use of a qualitative single case study design and provides an overview of each individual who is a unit of analysis. It also explains the matched pairs sampling, data collection and analysis techniques used in the study. Chapter 4 uses the matched pairs sampling method described in Chapter 3 to test propositions underpinning the theoretical framework presented in Chapter 2 and offers recommendations to policymakers, agribusinesses,

application developers, and other stakeholders aimed at improving the adoption and efficiency of mobile applications in agricultural extension in South Africa. The thesis closes with Chapter 5 which concludes the previous chapter.

## 2 Literature review

### 2.1 Introduction

This chapter reviews the relevant literature on agricultural extension, particularly participatory extension, and information and communications technology adoption and presents a theoretical framework on which propositions relating to the adoption of mobile applications for participatory extension will be based.

### 2.2 Agricultural extension: definition and approaches

The concept of 'extension' is widely understood and accepted by people working within extension organisations, yet there are several definitions of agricultural extension. Van den Ban and Hawkins (1996, pp. 9) define extension as "the conscious use of communication of information to help people form sound opinions and make good decisions". This definition is unclear on extension objectives beyond the formation of opinion and the increase of farmer knowledge. It does not consider how extension can enable farmers to identify their problems, clarify their goals and make good decisions in the future. The Food and Agriculture Organisation (FAO) defines extension as, "a service or system which assists farm people, through educational procedures in improving farming methods and techniques, increasing production efficiency and income, bettering their levels of living and lifting the social and educational standards of rural life" (Swanson, Sands & Peterson, 1990, p. 1). Although this definition goes beyond the formation of opinion and the increase of farmer knowledge, it still paints extension as a linear process where the farmer's role is solely to be a receiver of information and education and not to be someone who can contribute as a partner in the learning process. In Christoplos (2010, p.3), the FAO definition is expanded to, "systems that should facilitate the access of farmers, their organisations and other market actors to knowledge, information and technologies; facilitate their interaction with partners in research, education, agri-business, and other relevant institutions; and assist them to develop their own technical, organisational and management skills and practices." These definitions are representative of how approaches to agricultural extension have evolved over the years from a top-down transfer of knowledge to systems which are more inclusive of the farmers' voice.

In this section, several extension approaches will be discussed as extension officers have been found to use a combination of them at any given point, however, for this study, more emphasis will be placed on the participatory approach.

### 2.2.1 The general agricultural extension approach

The general agricultural extension approach was first introduced in the 1950s and 1960s with the aim of helping farmers increase their production. The approach assumes that farmers are not using the available technology and information because they are unaware of their existence, and if farmers were made aware, they would use these technologies and information and improve their farm practices. Within this approach, the planning of general agricultural extension programmes is controlled by the government, and they bear most costs. This approach requires high numbers of field staff assigned according to governmental structure throughout a country, usually centrally managed. This method has high operational costs, which considering a limited budget lead to compromises elsewhere, usually in travel expenses and training of extension workers, this results in incompetent officers with limited reach to farmers. This system was later found to be ineffective and subsequently abandoned in most countries, some of whom had accumulated large amounts of foreign debt in an attempt to improve their institutional, infrastructure and human resource development, and to sustain the operating expenditures of the system (Swanson et al., 1990).

### 2.2.2 The training and visit approach

The training and visit approach was promoted by the World Bank between 1975 and 1995 in more than 70 countries (Umali & Schwartz, 1994). The underlying assumptions of the training and visit approach is that under the general extension system, extension workers were poorly trained, lacked supervision and logistic support, and had no contact with farmers. To address this, the system has a strongly hierarchical system, with several levels of supervisors and subject specialists. In-house subject specialists offer training to field-staff, who in turn disseminate technical knowledge to villages on a strict two-week visitation cycle. This approach emphasises creating a direct link between research and extension, seasonal workshops with research



personnel are an integral part of the approach (Anderson & Feder, 2004). Under the training and visit approach, extension officers broadcast simple research-validated technical messages to some key farmers, known as 'contact farmers'. The role of the contact farmers is to disseminate their new knowledge within their neighbourhoods. This method alleviates the farmer contact issue of the general approach, however, in many cases, the benefits of this method were found to be biased towards more affluent farmers (Faure, Desjeux & Gasselin, 2012). The training and visit approach alleviated some weaknesses of the general extension approach, but it also aggravated other weaknesses, and in the end, the approach was found to be inefficient (Anderson & Feder, 2004). Although some Sub-Saharan African countries still use this approach, staff remunerations take almost the entire extension services budget and funds for operations are only made available under special projects and programmes. Thus, under current conditions, the approach is financially unsustainable and is unlikely to effectively contribute to agricultural or national economic development (Kidd, Lamers, Ficarelli, & Hoffmann, 2000)

### 2.2.3 Fee-for-service and privatised approach

In developing countries, fee-for-service programs can reduce the fiscal burden of public extension services. Within this approach, user-specific extension services are typically contracted from private providers by small farmer-groups. The extension service providers are directly accountable to the farmers who have contracted them. Due to this direct accountability, private extension is viewed to be of better quality than public extension (Anderson & Feder, 2004). The costs of the private extension service can be entirely borne by the farmer or the group of farmers or be shared with the government. An example of extension services cost sharing is Costa Rica's voucher schemes; a specific budget is allocated by the government to subsidise farmers' access to private extension services. The vouchers are awarded to farmers based on their farm type and technology level (Kidd et al., 2000). Completely privatised extension services are highly effective among larger-scale farmers and for high-value enterprises, but poorer farmers have been found to have a lower perceived value of the information and therefore do not find private extension services to be a reasonable expense (Anderson & Feder, 2004). Privatised extension delivery is

often promoted for its demand-driven and cost-effective nature; however, determining a fair, non-socially exclusive fee for extension delivery has proven difficult. (Kidd et al., 2000).

#### 2.2.4 Participatory extension approach

Until the late 1980s extension in developing countries consisted mainly of delivering generic technical knowledge to farmers without considering their specific needs (Hagmann, Murwira, & Connolly, 1999). Although farmers are keen to learn, they do not adopt whatever they are exposed to just because it is expected of them. Farmers more readily adopt technologies or ideas that are compatible with the practices to which they are accustomed. Traditional, linear methods of extension underperformed because they were not building on existing local experience. Rural communities did not have any sense of ownership of the ideas imposed on them (Isubikalu, 2007). This underperformance led to extension providers recognising the need to move away from commands and generic solutions, towards more participatory approaches that support community capacity building (Hagmann et al., 1999).

##### 2.2.4.1 *Participatory extension: definition, underlying concepts, and motivation*

The participatory extension approach, as defined by Hagmann et al. (1999, p. 2), is, “an extension approach and concept which involves a transformation in the way extension agents interact with farmers.” The underlying assumption of participatory extension is that farmers have a wealth of wisdom regarding food production on their land, but, they could also benefit from external insights. Further, it is based on the belief that effective extension cannot be achieved without farmers’ active participation, that farmers, researchers, and related services need to work together because group learning and group action have a reinforcing effect. Extension efficiency is believed to be gained by delivering demand-driven extension services through farmer organisations rather than through individualised approaches (Pretty, 1995).

According to Hagmann et al. (1999), participatory extension is characterised by:

- The integration of community mobilisation for planning and action.

- Being based on knowledge-sharing and equal partnerships between farmers, researchers and extension agents.
- The strengthening of rural people's problem-solving, planning and management abilities.
- The promotion of farmers' adaptation and technology innovation capacity.
- The encouragement of farmers to learn through experimentation, blending new ideas with their existing knowledge and practices.
- The recognition that communities are not homogenous, and that achieving sustainable development requires the negotiation of the interests of diverse groups and including the poor and marginalised in decision-making.

The major shift in orientation from the linear approach occurred when the improvement of farmers' development and innovation capacity, rather than mere transfer of information, became recognised as the foundation of agricultural development. The primary target of agricultural development then shifted to being human capacity building. This shift resulted in a change in the role of agricultural extension agents, from merely being agents of technologies imposed from the outside to becoming catalysts helping communities achieve goals they defined for themselves (Hagmann et al., 1999).

Participatory extension considers that there is a multitude of factors affecting how a farmer will choose to farm and that outsiders cannot fully understand the factors influencing local farmers' decision-making process. Successful technology development requires farmers to experiment with ideas and techniques and adapt, evaluate and determine the practices most appropriate for their situation (Hagmann et al., 1999).

#### *2.2.4.2 Advantages, disadvantages, and challenges of the participatory extension approach*

Participatory approaches to extension emerged as a response to the continued failure of the linear model. It was realised that most technologies developed by researchers alone were inappropriate for smallholders (Hagmann et al., 1999). Thus, participatory extension is characterised by being demand-driven. Extension services are delivered by public, private, NGO

or farmer organisation providers based on the needs of farmers and rural communities (Akinagbe & Ajayi, 2010). In theory, the participatory approach is supposed to encourage feedback of information and provide a platform of joint learning and contribution, as there is no rigid hierarchy and the complexity of socio-organisational issues is considered. However, van den Ban and Hawkins (1996) discovered that even within participatory extension systems it is difficult to get the poor and vulnerable in society to participate in decision making. Poorer and less powerful members are often afraid to disagree with people from whom they rent land, borrow money or for whom they work as labourers. This self-censorship then leads to a situation where the farmers with the most resources get their extension needs met at the expense of the more vulnerable farmers.

Participatory extension is decentralised, to alleviate the bureaucracy linked problems, such as lack of accountability, poor coordination with the broader policy environment, lack of fiscal sustainability, and reduced interaction with other stakeholders that come with a centrally administered system (Anderson & Feder, 2004). Decentralisation is also supposed to provide the advantage of improved management capacity as the scale of operation for each decision-making unit is reduced (Swanson, Singh & Reddy, 2008). However, merely transferring extension responsibilities to local governments without a change in organisational functioning and mindset only leads to the establishment of smaller, yet still rigidly hierarchical extension systems. The development of an appropriate participatory system requires extension professionals and other stakeholders to view farmers as sources of knowledge and as people who are capable of fostering their own development (Isubikalu, 2007).

The participatory extension approach challenges governments and development agencies to promote authentic and viable farmers' organisations to serve as channels through which farmers can take part in decision making. One way in which farmers' voices can be amplified is through the Farmer-Group method. The Farmer-Group method plays a significant role in policy advocacy and in realising economies of scale. Farmers support each other to learn and adapt, thus amplifying farmer-farmer extension. Farmer groups come in various forms, including co-operatives, informal-farmers' associations, multi-purpose groups and national farmer's

organisations (Akinagbe & Ajayi, 2010). They have the benefits of making agricultural extension services more client-driven and efficient; strengthening farmers' bargaining power with traders, reducing transaction costs for input supplies and output buyers; achieving economies of scale; facilitating savings and access to credit; and reducing public-sector extension costs (Conroy, 2003). However, weak institutional arrangements have led to a decline of cooperatives in many developing countries, and poor farmers are losing out on the benefits of collective action (Chibanda, Ortmann, & Lyne, 2009). Supporting infrastructure, institutions and organisational functions are crucial to the success of participatory extension.

One of the key motivations for the participatory approach is that outsiders cannot effectively determine the best practices for rural people. Farmers, who understand the social and environmental constraints they face, are best suited to make effective decisions about how to manage their farms. However, farmers' management and problem-solving capacity must be built first, and this requires collective learning through practical fieldwork (Hagmann et al., 1999). Farmer Field Schools (FFS) are a form of participatory extension that involves practical fieldwork. Groups of 20-25 farmers meet informally, regularly, usually in their own environment, and they conduct research, diagnose and test problems, and come up with solutions under the guidance of extension workers. The FFS method transforms farmers from recipients of information to generators and manipulators of local data. A significant drawback of the FFS approach has been its cost. The intense training activities are expensive per farmer trained, and this constrains the level of service delivered on a national scale. The schools are supposed to produce farmers who can facilitate and lead their own FFS the following season; this would make the system more sustainable as farmer-trainers would become the leading trainers. The method would further be improved by the community contributing to the funding of FFS and through improving the effectiveness of farmer-to-farmer knowledge diffusion (Anderson & Feder, 2007).

The graduation of farmers from FFS to trainers in their own right and farmer-to-farmer knowledge diffusion is integral to the sustainability of FFS. Farmer-to-farmer extension (FFE) complements formal extension services in facilitating the diffusion of agricultural technologies and improving farmers' capacities. For FFE programmes to be effective and sustainable, the

technical skills of volunteer farmer trainers need to be improved so that they are equipped to adapt and overcome systemic challenges to achieve the desired outcomes (Kiptot & Franzel, 2015). Volunteer farmer trainers also called model, master or lead farmers are individual farmers who have been chosen based on their agricultural expertise, and networking and training skills. Extension organisations often make use of master farmers because they can reach farmers at a lower cost, farmers are believed to have higher levels of trust in fellow farmers and the model is perceived to be sustainable (Khaila et al., 2015; Tripp et al., 2005). Mulanda et al. (1999) found that master farmers stand a chance of communicating technical concepts to fellow farmers better than technicians because they know the audience and language better and use expressions that suit their environment. Master farmers instil confidence in their fellow farmers as they demonstrate new practices, fellow farmers feel that if the master farmers can do it, so can they. Therefore, master farmers will be particularly effective if they are not of a much higher social status than those they train.

Wellard et al. (2012) reviewed community extension approaches in Ghana, Uganda and Malawi and they found that FFE can help facilitate innovation in sustainable agriculture and reach the poor, cost-effectively complementing existing extension services. Similarly, Lukuyu, Place, Franzel, & Kiptot, (2012) assessed the effectiveness of farmer trainers in disseminating agricultural technologies in Western Kenya. The farmer trainers had started working as part of a collaborative project aimed at disseminating agroforestry technologies; the farmer trainers continued disseminating other technologies after the project ended. Lukuyu et al. (2012) found that the farmer trainer method could potentially be used to distribute technologies to farmers in a cost-effective way that is sustainable beyond project lifetimes. They also confirmed that farmer trainers do not require financial rewards to be effective trainers; non-financial and indirect financial rewards suffice. In Peru, farmer trainers known as the Kamayoq carry out FFE. They started out focusing on irrigation techniques then broadened their focus. The success of the Kamayoq led to an NGO opening a school for training Kamayoq, the instructors in the school include staff from the NGO and some long-serving Kamayoq. The Kamayoq programme has been a great success; the key to the Kamayoq success is that local farmers highly value the assistance provided by their fellow Kamayoq that they pay for their services in cash or kind. The Kamayoq

case is an example of the upscaling potential of FFE. Another way is through the addition of a community knowledge worker onto the FFE model. The community knowledge worker would be equipped with a smartphone to improve farmers' access to information and virtually supported services (Khaila et al. 2015).

### 2.3 ICT and agricultural extension

Information and communication technology (ICT) has long been viewed as a useful tool in the dissemination of knowledge. ICT presents a chance to change agricultural innovation and development by fostering multi-disciplinary to enhance the innovation and knowledge diffusion process. The ability of ICT to simplify farmer-to-farmer communications and aid knowledge diffusion could potentially revolutionise participatory extension. Mobile applications, in particular, link previously isolated farmers to information on prices, farming best practices, extreme weather, and pest or disease outbreaks. Access to this information allows farmers to react to unfavourable agricultural conditions more effectively and improves their resilience (World Bank, 2011).

ICT solutions are increasingly being applied to agricultural value chains, research, and extension. While these solutions show considerable potential, there is need to fully understand what impact they can have on farmers, how they can contribute to sustainable growth in agriculture and how farmer reception of them can be improved. To this end, several studies have been conducted on ICT and agricultural extension.

According to FAO (2013), ICT solutions can address a wide range of gaps and inefficiencies in agricultural value chains through strengthening market linkages and providing accessibility to otherwise informal or unorganised populations. ICTs also provide a unique platform for fast and efficient data and information sharing which not only helps with farmer productivity but can also help inform rigorous policy and support the development of improved services to farmers and other value chain actors. A study by Tata and McNamara (2018) provides some empirical evidence to FAO's broad assessment of ICT solutions in agriculture. In their study of the impact of ICT on agricultural extension services delivery using evidence from the Catholic Relief Services

(CRS) SMART skills and Farmbook project in Kenya, they found that extension officers using the CRS SMART skills and Farmbook technologies served significantly higher numbers of farmer groups and spent more time on practical demonstrations than officers in the control group. This finding shows that the use of ICTs in agricultural extension can help officers improve the quality and quantity of work performed.

Similarly, Cameron et al. (2016) found ICTs to have a positive impact on agricultural extension. Their study reviewed Plantwise, a programme aimed at delivering plant health knowledge to smallholders in over 34 developing countries across Asia, Latin America and Africa using ICT based knowledge banks. They reported that the programme's pest management decision guides are promoting step-by-step planning and decision making by advisors and farmers and encourages the use of the least toxic pesticides by excluding all internationally restricted, banned and World Health Organisation (WHO) Class 1a and 1b classified pesticides. Extension officers within the programme reported that the Plantwise Factsheets application gives them accurate, comprehensive and detailed information at their fingertips and farmers reported increased confidence in the extension officers.

While these programmes are examples of the successful implementation of ICT in agricultural extension, they have their fair share of challenges. Tata and McNamara (2018) found that socioeconomic factors like gender, age and education influence the use of technology and extension service delivery. Extension officers also listed absent farm records, low farmer literacy, poor internet connectivity, and insufficient technical support as some of the challenges faced when using Farmbook. These are some issues which are prevalent amongst smallholders in developing countries, for any ICT intervention to succeed it is vital that they are identified and addressed.

The successful uptake and integration of ICT into agricultural services depend largely on public provision of infrastructures like power grids, telecommunication services and improved roadways (FAO, 2013). In most developing countries these public services are insufficient. Therefore smart systems design is required. Rose et al. (2016) conducted a study modelled upon



the unified theory of acceptance and use of technology to assist the delivery of existing agricultural extension ICT tools and the design of future tools. They came up with 15 factors to consider when designing an effective agricultural extension ICT tool. These 15 factors are clustered into their key themes in this review. Firstly, they suggest that the system must offer a demonstrable value to farmers to make participation worthwhile and that the information and advice the system offers should be actionable, relevant to farmers' enterprises and farming scale, and match closely with existing habits of farmers. Secondly, given the age and education variation amongst smallholders the system should be easy to use, matching the skills and habits of different age groups and with a user interface that is easy to navigate. Lastly, the system should be from a trusted source and be able to work under a wide array of conditions such as limited internet access.

## 2.4 Theories, perspectives, and frameworks for the study of adoption

User acceptance of technology has been an important field of study for over three decades. Knowledge of the factors that influence users' decision to use technological systems is essential for decision-making in new technology development (Mathieson, 1991). Many models have been proposed to explain the use of a system, these models, such as the Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB), Innovation Diffusion Theory (IDT), Model of Personal Computer Utilisation (MPCU), Motivational Model (MM), Social Cognitive Theory (SCT), Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) introduce factors that can influence users' acceptance of technology (Venkatesh, Morris, Davis, & Davis, 2003). This section discusses some common adoption models with emphasis on TAM, the most popular adoption model, and UTAUT, the model of choice for this study.

### 2.4.1 Theory of reasoned action

The theory of reasoned action, developed by Fishbein and Ajzen, has been widely used to predict behaviour and behavioural intentions. According to the theory, behavioural intentions, which it views as immediate antecedents to behaviour, are a function of salient evidence or beliefs about

the probability that performing a specific behaviour will lead to a particular outcome. The theory postulates that an individual's decision to perform a behaviour is determined by their attitude and subjective norms, and these are influenced by the individual's behavioural and normative beliefs, respectively. It also assumes that variables outside of the model influence intentions only through their effect on either attitudes or subjective norms (Fishbein & Ajzen, 1975).

The theory recognises three boundary conditions that can influence the relationship between intentions and behaviour: (1) the degree of correlation between the measure of intention and behavioural criterion, (2) the stability of intentions between time of measurement and performance of the behaviour, and (3) the degree to which carrying out the intention is under the volitional control of the individual (Madden, Ellen & Ajzen, 1992). The volitional control aspect is a source of the greatest weakness of the model. The development and testing of the theory were predicted on the assumption that the behaviours being studied were under the individual's full volitional control (Madden, Ellen & Ajzen, 1992). However, this is not always the case. When an individual forms an intention to act they are not always free to act on it without limitations. In practice, constraints such as time, physical ability, environmental or organisational limits and unconscious habits will limit the freedom to act. Ajzen improved on this weakness of the TRA by formulating the theory of planned behaviour.

#### 2.4.2 Theory of planned behaviour

Ajzen's (1985) theory of planned behaviour extends the boundary condition of pure volitional control specified by TRA to consider that resources and opportunities affect individuals' ability to perform behaviours. This variable is termed behavioural control and the more resources and opportunities an individual thinks they have, the greater their perceived behavioural control will be. TPB views perceived behavioural control as an exogenous variable that has both a direct effect on behaviour and an indirect effect on behaviour through intentions. When individuals lack the necessary resources to perform a behaviour, their intentions to perform said behaviour will be low despite having positive attitudes and subjective norms. Their lack of resources will have them believe they have limited control over performing the behaviour; thus perceived behavioural control will indirectly influence their behaviour (Madden, Ellen & Ajzen, 1992).

While the addition of the behavioural control component was an improvement from the TRA, TPB has some weaknesses of its own. Firstly, while the model considers social influences, it fails to consider environmental or economic factors that may influence an individual's intention to perform a certain behaviour. Secondly, it does not account for other variables that influence behavioural intention such as experience, threat and so on. Thirdly, it assumes that behaviour is a result of a linear decision-making process and does not consider that it can change over time. Finally, the time frame between intent and behavioural action is still not addressed by the theory (Manstead & Parker, 1995).

#### 2.4.3 Innovation diffusion theory

The innovation diffusion theory was introduced in 1962 but later refined by Rogers (1995). The theory focuses on understanding how innovative ideas and technologies spread in a social system (Wani & Ali, 2015). While adoption and change theories focus on persuading individuals to change, "IDT sees change as being the 'reinvention' of products and behaviours, so they better fit the needs of individuals and groups. According to the theory, it is not people who change, rather the innovations themselves" (Robinson, 2009, p. 1).

There are four main elements to IDT, namely: innovations, communication systems, time and social systems (Sahin, 2006). Innovations are the actual ideas, practices or objects perceived as being new by an individual, group or organisation. Innovations also include products or systems which may be pre-existing but have never been used by the individual. Communication systems are the channel through which users share information. An effective communication system results in quicker innovation diffusion. Mass media and interpersonal communication are examples of communication systems. IDT measures adoption time from the moment an innovation is created until it is no longer considered an innovation. Through the time aspect, IDT categorises adopters into innovators, early adopters, early majority, late majority, and laggards. Generally, individuals within a category share similar characteristics (Wani & Ali, 2015).

IDT's emphasis on the four elements and the categorisation of adopters means looking at the four main elements and categorising of adopters means that it is more focused on the system

characteristics, organisational attributes, and environmental aspect. The theory has less explanatory power and is, therefore, less practical for prediction of outcomes compared to other adoption models (Taherdoost, 2017).

#### 2.4.4 Technology acceptance model

The technology acceptance model has captured the most attention in the information systems community. Davis (1985) introduced the TAM as an adaptation of the theory of reasoned action (Fishbein & Ajzen, 1975) to model user acceptance of information technology. He proposed an individual's use of a system is determined by their motivation, which in turn is influenced by a combination of the system's features and capabilities. Davis (1985) suggested that users' motivation to use a system is defined by three factors, attitude, perceived usefulness, and perceived ease of use. He hypothesised that the attitude of a user toward a system was a major determinant of system use and that this attitude was influenced by perceived ease of use and perceived usefulness. Both perceived ease of use and perceived usefulness were hypothesised to be directly influenced by external variables (see Figure 2.1).

Many studies have been conducted using TAM, and they generally found that there is indeed a significant influence of perceived usefulness on behavioural intention to use a specific system. However, there were mixed results for the direct relationship between perceived ease of use and usage behaviour (Yousafzai, Foxall & Pallister, 2007). For example, Davis (1989) claims that an application perceived to be easier to use compared to another is more likely to be accepted by users.

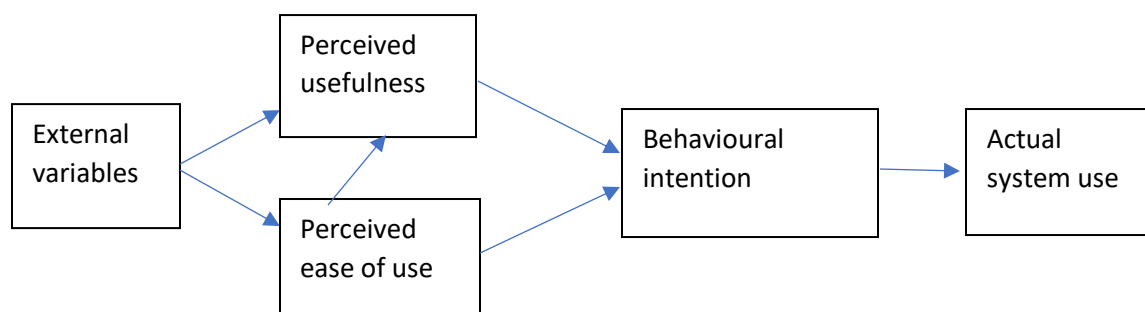


Figure 2.1. Technology Acceptance Model (Venkatesh & Davis, 1996, pp. 453)

However, according to the cost-benefit paradigm, individuals decide by considering a trade-off between the effort required to employ what is proposed and the quality of the results from employing the said proposition. If an application is easy to use but has little usefulness, it is unlikely to be adopted because it will not be producing the desired outcome. An exception may arise when the use of a system is mandatory. In these circumstances, Brown, Massey, Mantoya-Weiss, and Burkman (2002) found that perceived ease of use had more impact on system acceptance as the user had to use it regardless of whether they found it useful or not.

Although TAM is a highly cited model, and several studies have confirmed its robustness, there are mixed opinions regarding its theoretical assumptions and practical effectiveness (Chuttur, 2009). According to Bagozzi (2007, p. 245), the intention-behaviour linkage, on which the TAM is based, is “probably the most uncritically accepted assumption in information systems research.” He questions the theoretical strength of the intention-actual use link and observes that behaviour is not a final goal as many actions are taken not so much as ends in and of themselves but rather as means to more fundamental goals or ends. TAM neglects the use-to-goal-attainment gap. He also explains that intention may not be representative of actual use because during the period between intention and adoption there may be uncertainties and other factors which may cause the individual to revise their intention. Bagozzi (2007) also criticises TAM’s deterministic structure, as it assumes that an individual’s act is determined entirely by their intentions to act. He argues that an individual’s intention could be subjected to evaluation and reflection which might direct them to reformulate their intention, which may lead to their taking a different course of action.

TAM has also been criticised for its sole focus on cognition and neglect of consumer emotion on technology adoption, as well as lack of consideration of group, cultural or social aspects of technology acceptance (Read, Robertson & McQuilken, 2011). To include these variables, Venkatesh, Morris, Davis, and Davis (2003) used TAM and several other rational behaviour theories and models to construct what they call the unified theory of acceptance and use of technology (UTAUT).

### 2.1.1. Unified theory of acceptance and use of technology

The unified theory of acceptance and use of technology (UTAUT) is comprised of eight major models and theories, namely: innovation diffusion theory (IDT), theory of reasoned action (TRA), theory of planned behaviour (TPB), social cognitive theory (SCT), technology acceptance model (TAM), model of PC utilization (MPCU), motivational model (MM), and combined TAM and TPB (C-TAM-TPB). UTAUT combines the most important constructs of the various theories and models and reorganises them into four key constructs, namely performance expectancy, effort expectancy, social influence and facilitating conditions (Table 2.1).

Table 2.1 Definition of the four constructs in the UTAUT model (Venkatesh et al., 2003)

Root constructs	Definition	Constructs	Models
Performance Expectancy	Performance Expectancy is defined as the degree to which an individual believes that using the system will help him or her to attain gains in job performance	Perceived usefulness Extrinsic motivation Job-fit Relative advantage Outcome expectations	TAM C-TAM-TPB MM MPCU IDT
Effort Expectancy	Effort Expectancy is defined as the degree of ease associated with the use of the system	Perceived behavioural control Facilitating conditions Compatibility	TPB, C-TAM-TPB MPCU IDT
Social Influence	Social Influence is defined as the degree to which an individual perceives that it is important that others believe that he or she should use the new system	Subjective norm Social factors Image	TRA, TAM, TPB/DTPB, C-TAM-TPB MPCU IDT
Facilitating Conditions	Facilitating Conditions are defined as the degree to which an individual believes that an organisational and technical infrastructure exists to support the use of the system	Perceived behavioural control Facilitating conditions Compatibility	TPB, C-TAM-TPB MPCU IDT

In the model, the four constructs are moderated by gender, age, experience and voluntariness of use, as shown in Figure 2.2 (Venkatesh et al., 2003).

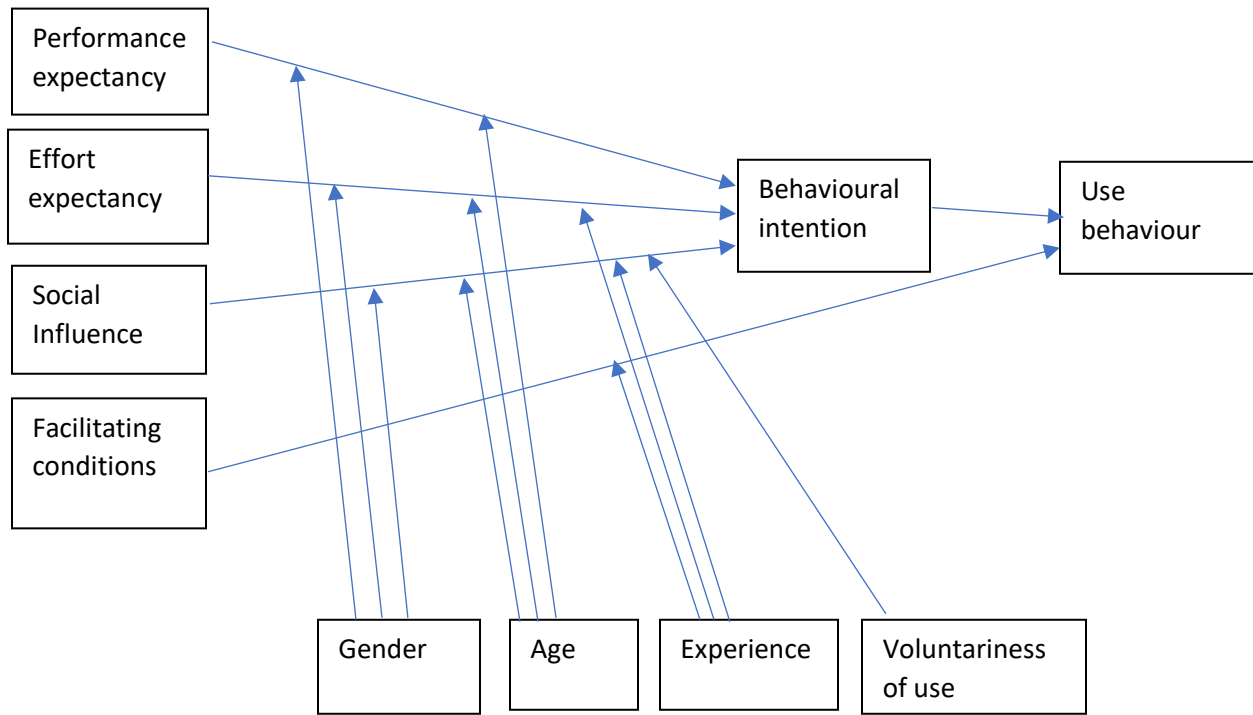


Figure 2.2 The UTAUT model (Venkatesh et al., 2003)

While UTAUT certainly considers more variables than TAM it still fails to bridge the intention-behaviour gap, it still views behaviour as a terminal goal and still considers intention as being representative of actual use. Essentially, it depicts technology acceptance as a linear model. Olson (2003) argues that farmers do not follow linear steps when making decisions, as decisions constantly evolve as new information arises. Moreover, the linear, step-by-step method does not take into consideration that, in most cases, agricultural technologies are introduced in packages. For example, high yielding varieties are often introduced with corresponding fertilisers and land preparation practices (de Aragao Pereira, 2011). This presents farmers with components which may complement each other but can also be adopted separately. Thus, farmers may face several distinct technological options, resulting in several adoption processes and sub-processes taking place simultaneously at different levels (Feder, Just, & Zilberman, 1985).

Despite these limitations, unlike the TAM, the UTAUT takes into consideration social influences and facilitating conditions. In a corporate context, on which TAM is based, social influence is not as important because technology users often must adopt as part of a business-wide initiative with little regard for personal feelings. However, in rural agriculture farming systems are part of a lifestyle and a culture. It is, therefore, more important for rural individuals to feel like their decision to use a particular system is supported by their social networks than for other people. In developed countries, the UTAUT model has indicated that facilitating conditions do not affect behavioural intention. However, whenever there are constraints on resources, as is the case in developing countries, facilitating conditions become an important predictor of behavioural intention (Thomas, Singh, & Gaffar, 2013).

## 2.5 Empirical studies on ICT adoption

In this section, empirical studies on technology adoption using both the TAM and UTAUT methods have been reviewed to highlight the differences and similarities. Furthermore, adoption studies based in South Africa have been reviewed to bring the study into a local context and to specify the gap in the literature further. Numerous empirical studies (Kwon & Chidambaram, 2000; Verma & Sinha, 2016; Yi & Hwang, 2003) have used the TAM to explain consumer intention to use a particular form of technology; these studies support the relationship between perceived ease of use, attitude, and intentions. Verma and Sinha (2016) surveyed 327 farmers who were using a mobile-based agricultural extension service to test their hypotheses that perceived ease of use, perceived usefulness and attitude towards mobile-based agricultural extension services positively influence behavioural intention (intention to adopt). Their study concluded that perceived usefulness had a positive influence on attitude and behavioural intention, attitude positively influenced behavioural intention, and the relationship between perceived ease of use and behavioural intention was not significant. Their findings were in line with Kortum and Sorber (2015) who found that in a survey of 3,575 mobile application users, the most popular applications had a usability average of 77.7 out of 100, a value much lower than anticipated. They suggested that although these mobile applications appear not to be perfectly usable, the utility and availability afforded by the applications may be high enough that people continue using them



despite their usability shortcomings. Both studies were based on voluntary use. To investigate adoption factors under mandatory conditions, Brown et al. (2002) carried out a field study in the banking industry where the use of a particular system was mandatory. In this instance, they found that perceived ease of use had more impact on system acceptance than perceived usefulness. The mandatory nature of use meant that it did not matter whether users found the system necessary or not, but the new system requiring less effort to use would encourage use.

TAM has been criticised for the limitations in the relationships present within the model and for missing some explanatory variables, particularly the emotional and social aspects of decision making. Read, Robertson, and McQuilken (2011) and Verma and Sinha (2018) factored these missing explanatory variables into their studies. Read et al. (2011) found that emotional attachment to paper books is weakly and negatively associated with consumer intentions to adopt e-readers. Verma and Sinha (2018) introduced social influence and perceived economic wellbeing into their study of the adoption of mobile-based extension services in India. They found that social influence affects attitude, perceived ease of use, perceived economic wellbeing, and perceived usefulness but not behavioural intention. The study also revealed that perceived ease of use and perceived economic wellbeing were antecedent to perceived usefulness. However, neither the behavioural intention nor attitude was impacted by perceived economic wellbeing. These studies indicate that there is an empirical basis for the UTAUT model which includes social influence, facilitating conditions and voluntariness of use as possible factors affecting behavioural intention.

The UTAUT model was used by Gupta, Dasgupta, and Gupta (2008) and Chen and Chang (2013) in their respective adoption studies. Gupta et al. (2008) explored the adoption of ICT (internet, intranet, extranet and enterprise resource planning systems) to enhance government-to-employee interactions in a government organisation in India. They found that performance and effort expectancy, social influence and facilitating conditions all positively influenced the use of ICT. Gender was found to have no moderating effect on these relationships. However, this may have been due to the skewed gender representation in the sample, with males making up 82% of the respondents.

Similarly, Chen and Chang (2013) investigated user acceptance of near-field communication mobile phone service in Taiwan. They added two extra variables to the UTAUT model, namely attitude towards using technology and anxiety about using the technology. They found that effort expectancy had a positive and significant effect on performance expectancy; performance expectancy and social influence had a positive effect on attitude towards the use of technology, but anxiety had a negative effect on it. They also found that attitude towards the use of technology had a more significant effect than facilitating conditions in affecting behavioural intention. A study by Moran, Hawkes & El Gayar (2010) on the integration of technology (tablets) into educational institutions supported Chen and Chang's inclusion of the anxiety construct into the UTAUT model; they also found anxiety to have a negative effect on individuals' intent to use a tablet. The study also found social influence and anxiety to have a different impact on different social groups.

Several other studies have extended UTAUT, including Wang and Wang's (2010) study of user acceptance of mobile internet in Taiwan with a specific interest in gender differences. They altered UTAUT by including three additional constructs, perceived playfulness, perceived value, and palm-sized computer self-efficacy, and omitting use behaviour, facilitating conditions and experience. In line with Venkatesh et al. (2003), the study found performance expectancy, effort expectancy, and social influence to have a significant positive influence on behavioural intention. They also found two of their three additional constructs to influence behavioural intention significantly. Perceived value and palm-sized computer self-efficacy were found to influence behavioural intention positively.

Regarding gender differences, Wang and Wang found that there were significant differences in the effects of the determinants on behavioural intention. Maillet, Mathieu and Sicotte (2015) included self-efficacy as a moderator for effort expectancy and compatibility of the system with existing practices as a moderator for performance and effort expectancy to study factors explaining the acceptance, actual use and satisfaction of an electronic patient record by nurses in acute care contexts. They found performance expectancy, facilitating conditions and effort

expectancy to have a significant positive effect on actual use. They also found a highly significant positive relationship between compatibility and performance expectancy.

Park et al. (2007) included education as one of the moderators of the key determinants of behavioural intention to study the adoption of mobile technologies amongst Chinese consumers. They found that performance and effort expectancy influenced behavioural intention significantly, while the effect of facilitating conditions was insignificant. They found the effect of social influence to be highly significant; this was as expected within a Chinese cultural context, where a strong adherence to social norms exists. The study went further to investigate the significance of the moderating effects, genderwise, they found men to be more influenced by performance expectancy, while women were more influenced by social influence when deciding to use mobile technology. Additionally, effort expectancy influenced women's behavioural intention more than men. Education, as a moderator of the antecedents of behavioural intention, was found to have significant explanatory power only amongst the low education group. When comparing the high and low education groups, the high education group was relatively less influenced by effort expectancy. To further investigate how individual characteristics influence ICT adoption Das (2014) studied how household, farm and technology characteristics influence smallholders' adoption of new technologies. The study found that if any member of a household engaged in farming had received any formal training the household's probability of adopting ICT was higher than that of a household with no member who has received formal training. It was also observed that households who produced non-food crops were less likely to adopt ICTs. Smaller farmers were also found to be less likely to adopt ICTs when compared with farmers with larger holdings. This difference in adoption levels may be due to the reduction in unit costs that comes with economies of scale (Ogutu, Okello, & Otieno, 2014).

Early empirical research on ICT in South Africa is mostly centred on access. Tlabela, Roodt, Paterson, and Weir-Smith (2007) used 11 separate indicators to analyse and map ICT access in South Africa. They discovered that in 2003, 13.6% of South African households had access to a personal computer. However, there was considerable variation between the different provinces, Gauteng and the Western Cape provinces had greater access, but third-ranked KwaZulu-Natal

had half the percentage access of Gauteng. Access is influenced by resource availability, and this study is largely representative of resource access in South Africa. Gauteng and the Western Cape provinces place first and second, respectively, in contributions to the country's per capita GDP. They are also the most urbanised provinces in the country (Statistics South Africa, 2011). Access affects capacity to adopt. Kyobe (2011) found that the capacity to adopt and use ICT had the most significant effect on ICT adoption in South Africa. Capacity to adopt and access ICT forms part of the facilitating conditions construct of the UTAUT key determinant, facilitating conditions.

In the UTAUT model gender moderates the effects of social influence, effort and performance expectancy on behavioural intention. Maleka (2012) conducted a gender-based analysis of ICT adoption in South Africa using secondary ICT data covering the years 2005-2010. He found no evidence of gender difference in the adoption of ICT in South Africa but found income, education, age, and location to be factors determining adoption. However, due to the existing gender disparities in income and education, and with the rural population being largely female, the analysis found that females were disadvantaged concerning broad ICT access.

Moving beyond access, Liebenberg et al. (2018) determined the applicability of the UTAUT model within a South African higher education context and clarified factors influencing students' acceptance of eBook and a Specialised Learning Management System. The study found the model to be a good fit to study technology adoption in a South African context, with three key determinants: performance expectancy, effort expectancy and facilitating conditions having a significant positive effect on behavioural intention. The study found performance expectancy to be the dominant key determinant of behavioural intention among the students. Like some of the other studies, Liebenberg et al. (2018) extended the UTAUT model by including attitude, anxiety, and self-efficacy as mediators of behavioural intention, and of the four original UTAUT moderators only gender had variation and could, therefore, be studied. They found that although a strong relationship exists between effort expectancy and behavioural intention, most of the relationship is mostly routed through self-efficacy and attitude, which means that the mediation effect is stronger on effort expectancy than on the other determinants. Contrary to the UTAUT

model, they found gender to have no significant moderating effect on the relationship between behavioural intention and the key determinants.

## 2.6 Theoretical framework

This study theorises that the efficiency of a mobile application in performing a particular task is a function of its characteristics and adoption. The characteristics of the application and their influence on the application's efficiency will be assessed using the PACMAD (People at the Centre of Mobile Application Development) concept. PACMAD is a model developed by Harrison, Flood, and Duce (2013) based on Nielsen's (1994) model for desktop application usability. According to PACMAD, seven attributes reflect the usability of an application: effectiveness, efficiency, satisfaction, learnability, memorability, errors and cognitive load. This study will evaluate the Lima application's characteristics based on these seven attributes.

### *Effectiveness*

Application effectiveness is the ability of a user to complete a task in a specified context. In this case, a facilitator being able to register a farmer fully would be an example of a measure of the application's effectiveness. Typically, effectiveness is measured by evaluating whether participants can complete a set of specific tasks (Maguire, 2001).

### *Efficiency*

Application efficiency refers to the user's ability to promptly and accurately complete a specified task. This attribute measures the user's productivity while using the application and can be measured in ways such as the number of keystrokes required to complete a task (Harrison et al., 2013).

### *Satisfaction*

Application satisfaction refers to how comfortable and pleasant the user finds using the application to be. Since user satisfaction is a subjective measure, questionnaires and other qualitative measures are typically used to determine it (Harrison et al., 2013).

### *Learnability*

Learnability refers to how easily a user can become proficient at using an application. This attribute can be measured by observing participants who are performing a series of tasks and measuring how long it takes them to reach a pre-specified level of proficiency (Harrison et al., 2013).

### *Memorability*

Application memorability refers to the ability of a user to remember how to use an application effectively after a period of no-use. This attribute is based on the finding that mobile applications are generally used on an infrequent basis. Therefore, there may be long periods of inactivity between uses and users may have to relearn using the application. Memorability may be determined by establishing proficient users' baseline proficiency and then measuring proficiency again after a period of inactivity (Maguire, 2001).

### *Errors*

The errors attribute is used to reflect how well the application user can complete the desired task without errors. It helps developers pinpoint the most troublesome areas for application users. The model highlights that users should make a few mistakes while using the system, but they should be able to recover from them quickly. The error rate of users may be used to infer the simplicity of a system (Harrison et al., 2013).

### *Cognitive load*

This attribute considers that unlike desktop applications, mobile application use usually includes performing additional tasks such as walking. The developer, therefore, must consider how using the application may influence these additional tasks. Cognitive load refers to the amount of cognitive processing required by the user to use the application (Oakley & Park, 2009).

The PACMAD model is the model chosen to evaluate the usability of the Lima Farmer Support application due to its emphasis on the user experience. The model looks beyond the effectiveness, efficiency and satisfaction, which are the most prominent attributes in usability models. The model considers other application attributes, such as cognitive load, which are also likely to impact the success of an application. PACMAD combines important attributes from different usability models to create a more comprehensive usability model (Harrison et al., 2013).

UTAUT will guide this study's investigation into the factors influencing the adoption of mobile applications. UTAUT is the chosen model, firstly, because it captures the social influence and facilitating conditions variables which are essential factors in the study's rural agriculture and developing country context. Secondly, because UTAUT is a fit model for studying technology adoption, and there is ample empirical evidence supporting the theorised relationships between behavioural intention, use behaviour and the key determinants (Wang & Wang, 2010; Gupta, Dasgupta & Gupta, 2008; Chen & Chang, 2013).

While empirical studies have shown some variations on how the moderating factors interact with the key determinants, this study elects to maintain the relationships theorised by Venkatesh et al. (2003). However, the study will extend UTAUT to include education as a moderator of social influence, effort and performance expectancy, and farming scale as a moderator of performance expectancy and effort expectancy. The model is extended to make it more relevant to the context of agriculture in a developing country. The theory has suggested that farmer education, particularly in developing countries where education levels may be meagre, and farming scale influence farmers' decision to adopt technologies (Park, Yang, & Lehto, 2007; Ogutu, Okello, &

Otieno, 2014). Figure 2.3 illustrates the theoretical framework for the study and the proposed relationships between key determinants, moderators, behavioural intention and use behaviour.

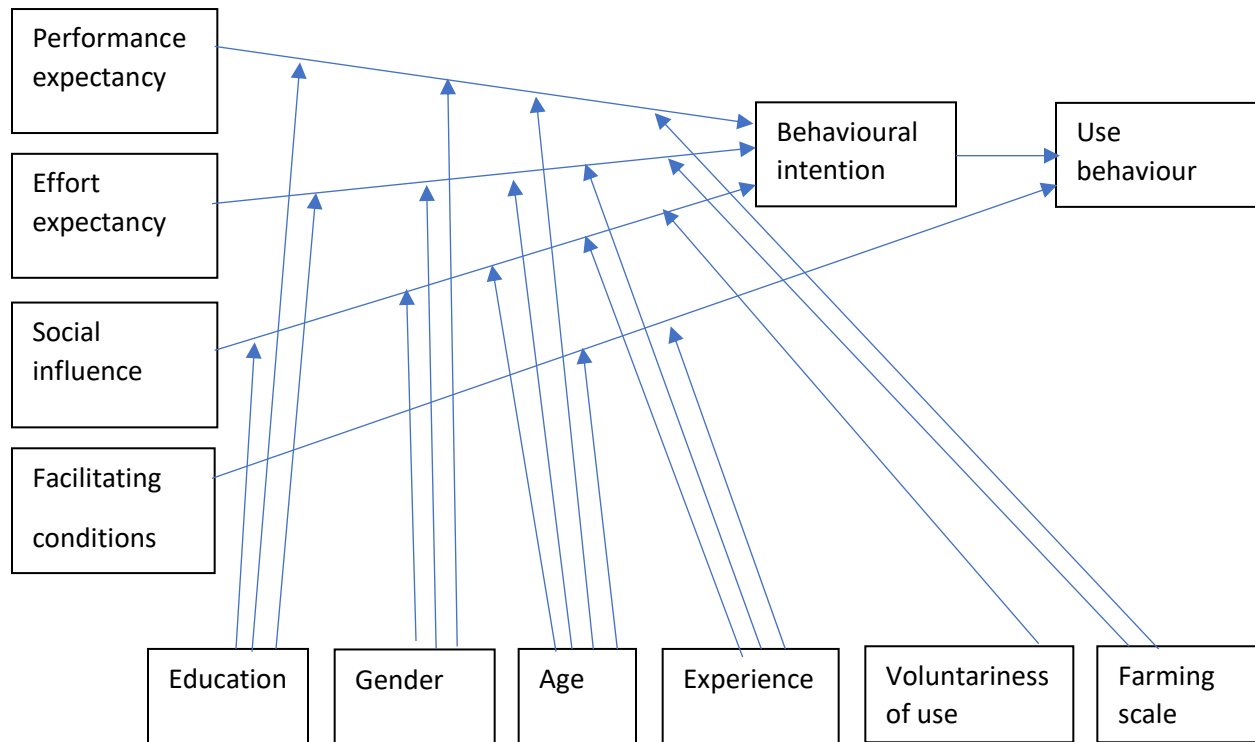


Figure 2.3 Anticipated relationships between key determinants, moderators, behavioural intention and use behaviour

## 2.7 Research gap and study relevance

Firstly, on a broader context, the researcher found limited literature on the adoption of ICTs, for a specified goal with an objective measure of system use (e.g., actual system access frequency recorded by a computerised system). Having an objective measure has been found to have many advantages over a self-reported measure. It can rule out reporting biases due to selective recall and inaccurate estimation and avoids inherent methodological problems such as common-method bias, hypothesis guessing, and indistinguishable causation, all associated with retrospective self-reported measures (Yi & Hwang, 2003). Secondly, in a South African context,



the researcher found no literature on mobile applications as a tool for agricultural extension, particularly literature aimed at assisting with the design of future agricultural extension applications. There is a need for a goal-oriented adoption study that considers behavioural intention as a means to a fundamental goal, and which encompasses the reflective nature of decision making. This research will undertake such a study to understand better the uptake of agricultural extension applications by facilitators serving small-scale farmers in parts of South Africa's Eastern Cape and KwaZulu-Natal provinces. The study will benefit policymakers who may be interested in knowing how infrastructure affects technology adoption and agricultural extension, extension managers who may want to know what factors can improve extension efficiency, and facilitators who may be able to channel their extension work to more responsive farmers. Feedback may help application developers to improve their applications in ways that make it easier for smallholders to use the application and benefit from it.

## 2.8 Research questions, research objectives, and theoretical propositions

The study will answer the research questions; how do facilitating conditions, application characteristics, and other moderating factors affect user acceptance of mobile applications for extension purposes, and how can mobile applications aid participatory extension? According to Yin (2003, pp. 1-14) and Marshall and Rossman (2014), 'how' questions are often best answered by qualitative research. Therefore, this research will draw on a single, qualitative, case study of Lima's Farmer Support Application to answer these questions.

This case study will be analysed using a pattern-matching logic. According to Yin (2003), a pattern-matching logic compares an empirically based pattern with a predicted one, or with several alternative predictions. If the patterns coincide, it strengthens the internal validity of the case study. In the case of an exploratory study, the patterns may be related to the dependent or independent variables of the study. If the case study is descriptive, the predicted pattern of specific variables must be defined before data collection.

For this study, the primary proposition is that the potential of mobile applications effectively aiding participatory extension is dependent on application characteristics, facilitating conditions and user acceptance. The objectives of the study and their corresponding propositions are:

1. To determine what factors influence the adoption of the Lima Farmer Support Application
  - The expected performance of the application will be a significant determinant of adoption.
2. To determine whether different levels of use exist between users, what features are most commonly used and why.
  - Different levels of application use will exist amongst the facilitators
  - Specific application functions will be used more frequently than others, and this will be demand driven
  - More use will be made of application functions perceived to be useful than those perceived to be easy to use
3. To establish what characteristics a high-level user of the application has.
  - Facilitators with higher levels of education will have higher levels of use.
  - Farmers who farm on a larger scale are more likely to find the application useful and therefore more likely to adopt the proposed mobile application
4. To establish what infrastructure supports the use of the application.
  - Facilitators who work in areas with better access to organisational and technical infrastructure will have higher levels of use.

## 3 Methodology

### 3.1 Introduction

This chapter describes the research methods employed in this study to collect data and test propositions about factors influencing the use of Lima's mobile extension application. The theoretical framework employed in the study was adapted from the unified theory of acceptance and use of technology developed by Venkatesh et al. (2003). This theory identifies several factors that influence a prospective adopter's intention to use new technology, and - subsequently - its actual level of use.

Section 3.2 highlights the strategy employed to carry out this study. Section 3.3 explains how data was collected and gives an overview of the research site and respondents' characteristics. Section 3.4 introduces the dependent variables and explains the method used to compute a comparable variable for the level of application use for each site. Section 3.5 explains how data will be analysed to refute or support propositions made in Chapter 2.

### 3.2 Research strategy: Single case study

The research was carried out using a single case study approach. Case studies are appropriate for research that seeks to address 'why' and 'how' questions (Yin, 1994, pp. 20-21). They involve deep qualitative analysis and are typically applied to investigations of phenomena that have a small sample size (Denscombe, 2014). In this research, a single case study comprising purposefully selected respondents provided the data required to confirm or refute the propositions presented in Chapter 2, and to better understand how application characteristics, performance expectancy, effort expectancy, social influence, facilitating conditions, gender, age, education, voluntariness of use and farming scale influence the potential for Lima's mobile application to support participatory extension. Information generated from this qualitative analysis will then be extrapolated to theory and not to a target population as in quantitative analysis (Eisenhardt, 1989; Hartley, 2004).

Facilitators and farmers were treated as holistic units of analysis as they could provide information about their own experience with the application. Interviews, observations, and

document analysis provided multiple sources of evidence to improve the case study's reliability and validity as recommended by Yin (2003).

### 3.3 Data and data collection method

The author collected both primary and secondary types of data from multiple sources, to improve the construct validity of the research through triangulation of the evidence (Eisenhardt, 1989). Primary data were gathered over six weeks between May and July 2018. Primary data collected included responses from interviewees, photographs, field notes and observations made by the Researcher. Secondary data were collected from March to August 2018. Secondary data included information from the Mid-Term Evaluation of the Smallholder Farmer Support Programme (JF/1011) and data from the Lima Info Systems Reporter. The Lima Info Systems Reporter is a platform used to collate data from the application and key documents from Lima.

#### 3.3.1 Method of data collection

Primary data were gathered in semi-structured interviews conducted with key informants. These informants were; facilitators and farmers from ten areas in which Lima operates, as well as managers and the application developers. Respondents were selected to ensure variation in explanatory variables; gender, education, age, nature of worksite (and farm characteristics in the case of farmers) and based on their willingness and ability to provide relevant information. Initial discussions with managers and the developers helped to identify facilitators for in-depth interviews. In turn, the facilitators identified farmers who met the selection criteria and who were considered capable of providing useful information. The interviews were guided by the topics listed in the guidelines appended in Annexes 1 and 2.

A total of 25 interviews were conducted; 11 were conducted with facilitators in their offices, 11 with farmers on their farms and work areas, one with a senior manager in her office, and two with application developers in their offices. All the respondents provided written consent to participate, have their interviews recorded, and to use their titles and names in this thesis. Primary data were also gathered through direct observation. The author observed facilitators using the application, visited some of the farmer respondents at their farms, and visited Lima's

facilities in each area where a facilitator was interviewed. During these visits, photographs and field notes were taken. These also form part of the primary data collection. Lima provided secondary data by email. Permission to use data captured by the Reporter was granted following a written request addressed to both Lima and the Jobs Fund. The Reporter assembles all the information processed by the application, allowing the user to access both summary and detailed information on the activities of the facilitators and their farmers' enterprises.

### 3.3.2 Human ethics consideration

The primary data collected were strictly of a professional nature. The Researcher understands the culture of the study area and knows the kind of questions that may be considered of a personal or sensitive nature. Care was taken to avoid such questions. Prospective respondents were advised that participation was voluntary and that their responses would remain confidential unless they consented to have their names disclosed in the thesis. Permission was granted by Lima and The Jobs Fund to access and use their secondary data, in accordance with South Africa's Protection of Personal Information Act 4 of 2013.

### 3.3.3 Purposive sampling: Case and respondents

Purposive sampling was used to ensure rich data and to generate information that would help to accept or reject the theoretical propositions (Eisenhardt, 1989, p. 537). A purposive sample is "a type of nonprobability sample. The main objective of a purposive sample is to produce a sample that can be logically assumed to be representative of the population. This sampling is often accomplished by applying expert knowledge of the population to select, in a non-random manner, a sample of elements that represent a cross-section of the population" (Battaglia, 2011, p.645). Lima managers, the application developers, facilitators, and the literature helped provide the expert knowledge necessary to purposively select respondents. Farmers were purposively selected for variation in location, farming scale, and enterprise, while facilitators were purposively selected for variation in location, education, age and gender.

Lima's mobile application was selected as the case study for this research as the NGO had developed and refined its own mobile application to support participatory extension services for

smallholders in the KwaZulu-Natal, Eastern Cape, Limpopo and Mpumalanga provinces of South Africa over several years and was both willing and able to provide relevant information. The study was conducted in three of these four provinces. In KwaZulu-Natal and Eastern Cape provinces, primary data were gathered in personal interviews conducted with facilitators and farmers. This was possible as there were relatively large numbers of users in reasonably close proximity and the Researcher could communicate freely with farmers in their own language. In Mpumalanga province, facilitators were interviewed telephonically owing to distance and time constraints.

### 3.3.4 Description of respondents

This section presents a brief overview of each respondent, describes their age, gender, the area they come from, and- in the case of farmer respondents - their core enterprises. Tables 3.1 and 3.2 summarise key attributes of the farmers and facilitators interviewed. The sample comprises 11 farmers and 11 facilitators. The application developers and one senior manager were also interviewed to provide context on the application's design and introduction process. In some cases, direct quotations from the interviews are altered to prevent ambiguity.

Most households engaged in agriculture in South Africa are located in the provinces of KwaZulu-Natal, Eastern Cape and Mpumalanga (Figure 3.1). In 2016, the Eastern Cape accounted for 21.3% of the country's agricultural households, KwaZulu-Natal for 23.0%, and Mpumalanga, 9.7% (Statistics South Africa (Stats SA), 2016, p.1). Mpumalanga and KwaZulu-Natal also have the highest incidence of agricultural household heads with 'no schooling', 26.3% and 22.7%, respectively (Stats SA, 2016, p. 4). The facilitators and farmers interviewed in this study came from different towns and districts within these provinces. These towns range in levels of infrastructure development as well as economic opportunity.

#### *KwaZulu-Natal: Ixopo*

Ixopo is a town situated on a tributary of the Mkhomazi River along the R56 highway in the Midlands of South Africa's KwaZulu-Natal province. This town forms part of a vital sugar farming and forestry area. It is part of the Buhlebezwe Municipality which is in the Harry Gwala District.

The Harry Gwala District is bordered by the Drakensberg Mountains, which form a 200-kilometre-long World Heritage Site. Economically, the most prominent employment sectors in the district are agriculture, construction and small-scale manufacturing. The area's unspoilt natural environment has high eco- and adventure-tourism potential (KwaZulu-Natal Department of Agriculture and Rural Development (KZNDARD), 2015). Semi-structured interviews were conducted with three respondents in Ixopo on the 25<sup>th</sup> of May. The respondents were Ms. Mncwabe, a facilitator, and two of her farmer clients, Mr. Zulu and Mrs. Jili.

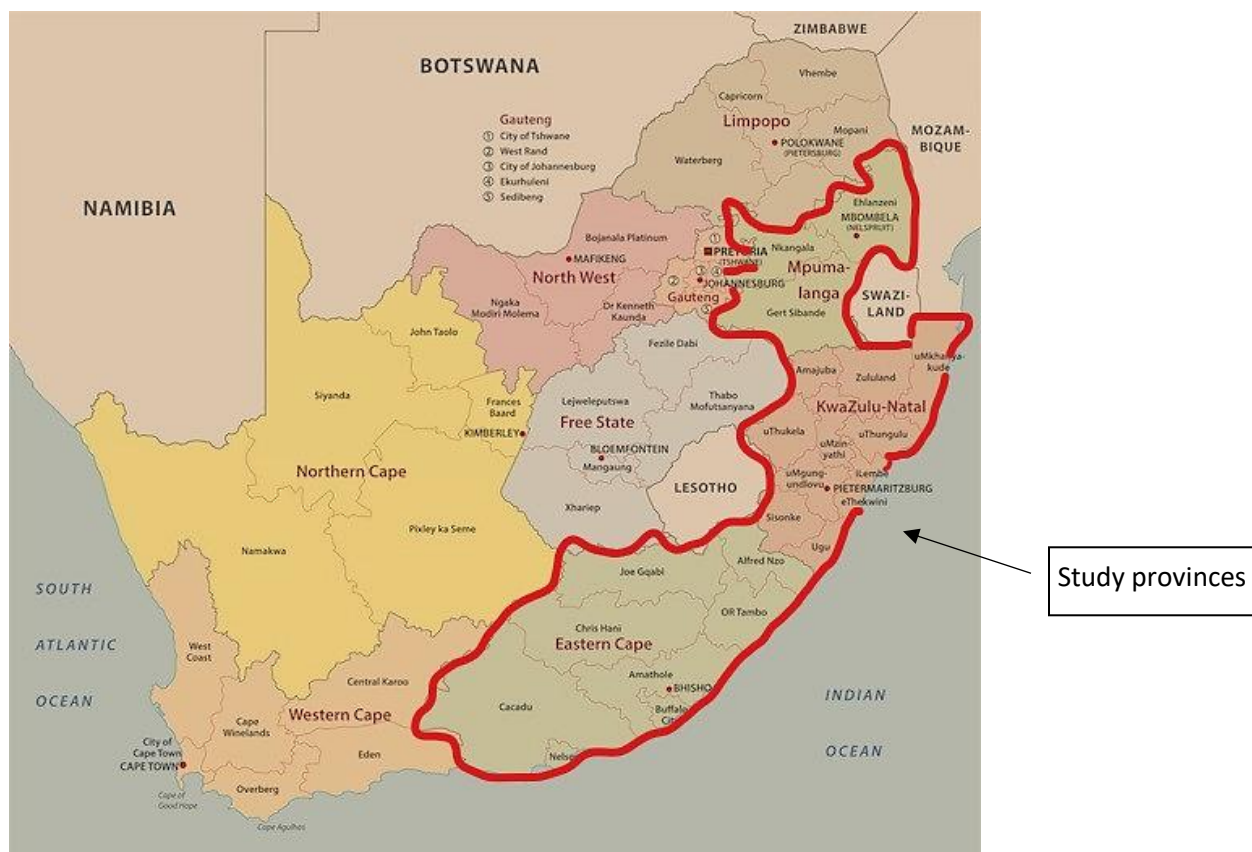


Figure 3.1. Study area: Provinces in South Africa (Source: Africa Map, 2013)

Table 3.1 Key characteristics of facilitator respondents

Facilitator	Town or district	Age (yrs.)	Gender	Education	Number of farmers	Length of app use
Ms. Mncwabe	Ixopo	27	Female	BSc. Agricultural Economics	854	1 year
Ms. Ngcobo	uMzimkhulu	25	Female	Diploma in Community Extension		1 year
Mr. Buthelezi	Bergville	27	Male	Diploma in Agricultural Management	907	7 months
Mr. Mathunjwa	Estcourt	32	Male	Diploma in Agriculture (Animal Production)	860	7 months
Ms. Nongogo	Matatiele	32	Female	Diploma in Agriculture (Crop Production)	1200	1 week
Mrs. Njeya	Bizana	50	Female	Secondary Education	1000	3 months
Mr. Madikizela	Lusikisiki	55	Male	Diploma in Agriculture	1200	2 years
Mr. Mhlakaza	Lusikisiki	33	Male	Secondary school	1200	
Mr. Ngcobo	Nkomati	45	Male	BSc. Agriculture	736	7 months
Mr. Tshivombela	Mopani	31	Male	BSc. Agriculture	725	8 months
Mr. Maja	Bushbuckridge	40	Male	BTech. Extension	1000	7 months

Table 3.2 Key characteristics of farmer respondents

Farmer	Location	Age (yrs.)	Gender	Enterprise	Scale	Smartphone ownership
Mr. Zulu	Ixopo	34	Male	Crop (cabbage)	Large	Yes
Mrs. Jili	Ixopo	66	Female	Crop (beans)	Small	No
Mrs. Ntuli	uMzimkhulu	30	Female	Poultry & crop (cabbage)	Large	Yes
Mrs. Mavuma	uMzimkhulu	33	Female	Poultry & crop	Small	Yes
Mrs. Mchunu	Estcourt	65	Female	Poultry	Small	No
Mr. Chonco	Estcourt	42	Male	Pork	Large	Yes
Mr. Magadla	Matatiele	59	Male	Beef	Small	Yes
Mr. Zondo	Bizana	65	Male	Poultry	Small	Yes
Mr. Armstrong	Bizana	47	Male	Poultry, Pork, Crayfish	Large	Yes
Mrs. Qwathekana	Bizana	75	Female	Crop (amadumbe & sweet potato)	Small	No
Mr. Dlamini	Bizana	35	Male	Crop (amadumbe & sweet potato)	Large	Yes



Ms. Mncwabe is a 27-year-old Bachelor of Sciences (Agricultural Economics) graduate from the University of KwaZulu-Natal. During her interview, she displayed a good understanding of mobile applications and their functions. She started using the Lima application early in 2017 and was part of the second round of application testing.

Mr. Zulu is 34 years old; he farms cabbage and spinach on roughly four hectares of land. Although he farms a relatively small area, Mr. Zulu has one of the highest revenues from his vegetables, from amongst Ms. Mncwabe's clients. His farm is an estimated three kilometres from town, this gives him access to a greater market, at a lower cost compared to someone from a more remote area. He has also secured a supply contract for his spinach and cabbage with a small local supermarket; he was looking to expand his production during the time of the interview.

Mrs. Jili is a 66-year-old bean and maize farmer. She farms on six hectares of land and does not have a guaranteed market. She believes that she is too old to own a smartphone and sees no need for one. She is welcoming of other forms of agricultural technologies, for instance, she is looking to invest in a mobile water pump which would give her the power to irrigate her crops, thus enabling her to diversify her produce.

#### *KwaZulu-Natal: uMzimkhulu*

uMzimkhulu is a small town, also in KwaZulu-Natal's Harry Gwala District. It is 18 kilometres from Ixopo and was first developed as a trading post. Over 90% of uMzimkhulu's population is rural-based. Many of its rural dwellers still live without basic services and have limited access to areas with better services due to poor road infrastructure (Figure 3.2). uMzimkhulu faces severe backlogs in terms of service delivery. Road infrastructure is poor and provides only limited access to the area (Stats SA, 2016).



Figure 3.2 A rural road under construction in uMzimkhulu

Semi-structured interviews were conducted with three respondents in uMzimkhulu, one at the Lima office and two on farms on the 28<sup>th</sup> and 29<sup>th</sup> of May 2018. The respondents were Ms. Ngcobo, the facilitator, and her farmer clients, Mrs. Ntuli, and Mrs. Mavuma. Ms. Ngcobo is 25 years old. She has a Diploma in Community Extension and recently moved to the uMzimkhulu office from the Ixopo office where she trialled the beta version of the application with Ms. Mncwabe.

Mrs. Ntuli is 30 years old. She and her husband plant cabbages (Figure 3.3) on approximately eight hectares of land and keep poultry. They produce two batches of chickens each month. One batch is intended to coincide with the pay-out of government grants, and the second with month-end. They sell their cabbages and chickens locally and at government pay points. The Ntulis have a tractor and some implements. They have specially constructed chicken coops which include gas heating, self-feeders and automatic poultry drinkers (Figure 3.4). Mrs. Ntuli owns a smartphone but does not use it for much, however, she says her husband follows several agricultural pages on Facebook and often uses his phone to search for information on Google.



Figure 3.3 A portion of Mr. and Mrs. Ntuli's cabbage farm



Figure 3.4 One of Mr. and Mrs. Ntuli's poultry batches



Mrs. Mavuma is 33 years old; she has chickens and a garden in which she plants beans, cabbages and spinach. Mrs. Mavuma has a makeshift cage for her chickens and manually fills the drinking buckets (Figure 3.5). She has a smartphone but does not use it for much beyond sending and receiving text messages and calls due to the high price of data bundles.



Figure 3.5 Mrs. Mavuma's chickens have a makeshift cage

#### *KwaZulu-Natal: Bergville*

Bergville is a small town situated in the foothills of the Drakensberg mountains in KwaZulu-Natal. The town is part of the uThukela District Municipality, a district on the western boundary of KwaZulu-Natal province. The district is 11500km<sup>2</sup> in size, and its population is predominately rural and very poor. It has a dispersed settlement pattern, and much of the land is underdeveloped (Figure 3.6). The District Municipality has insufficient revenue to maintain its infrastructure and

to provide adequate social services. Levels of education are low, and there is an acute shortage of skills despite high rates of unemployment (KZNDARD, 2015).



Figure 3.6 A typical village in the uThukela District

A semi-structured interview was conducted with one respondent in Lima's Bergville office on the 5<sup>th</sup> of June 2018. The respondent was Mr. Buthelezi, a facilitator for the Bergville area. Mr. Buthelezi is 27 years old and has a Bachelor of Technology in Agricultural Management from the Nelson Mandela Metropolitan University. He started working for Lima as an intern and initially used a laptop-based version of the application. He started using the mobile version at the end of 2017.

#### *KwaZulu-Natal: Estcourt*

Estcourt is also a town in uThukela District. It is situated 41 kilometres west of the Drakensberg mountains and is the largest commercial and service centre in the Midlands region. Neighbouring towns like Bergville, Weenen, Mooi River, Colenso, and Winterton rely heavily on the over 600 businesses found in Estcourt. The town is also home to some of South Africa's well-established

industries such as the Eskort Bacon Factory, Nestle, Narrowtex and Clover. These manufacturers serve both the South African market and the export market. It is estimated that the areas surrounding Estcourt are home to a quarter million people, mostly living in the rural environment, from which these factories draw a great deal of their labour (Inkosi Langalibalele Municipality, n.d)

Three semi-structured interviews were conducted in Estcourt on the 6<sup>th</sup> and 7<sup>th</sup> of June 2018. The respondents were Mr. Mathunjwa, the facilitator, Mrs. Mchunu as the key respondent for a women's poultry and crafts co-operative and Mr. Chonco as the key respondent for a piggery partnership.

Mr. Mathunjwa is 32 years old and has a Diploma in Agriculture specialising in Animal Production. He says he started using the application after the training in Pietermaritzburg. Although he does not own a smartphone, he says he found adjusting to the app fairly easy due to the training. The poultry and crafts cooperative is mostly comprised of retired women; their average age is 63 years. Mrs. Mchunu is 65 years old, she was born, raised, and spent most of her professional life in Pietermaritzburg. She used to work as an orderly in a nursing home in Pietermaritzburg before retiring to Wembezi, Estcourt. She and the other members started the cooperative because they wanted a form of income to supplement their pensions and to empower other women in the area. The facilities they are using were donated to the area by a private company, the facilities do not have a formal caretaker, and there are regular issues about maintenance responsibilities. These maintenance issues have led to them being without electricity over the last few months, resulting in their being forced to halt their poultry production as the area is frigid and they rely on the electricity to keep the chickens warm. The cooperative's beadwork, shoemaking, and dressmaking have kept their doors open (Figure 3.7).

Mr. Chonco's piggery lies about 20 kilometres from the town of Estcourt, he, along with his brother and uncle co-own the business. Mr. Chonco is responsible for the piggery's daily operations. He is 42 years old and has done several courses on piggery through Cedara College in Pietermaritzburg.



Figure 3.7 Some of Wembezi Women's Cooperative crafts on display

The piggery has 11 sows, five gilts and two boars. His initial stock and the structure were given to him by his uncle Mr. Tenza, a co-owner in the piggery. Mr. Tenza is in his seventies and prefers to be in the background of operations. Mr. Chonco has built himself a network of helpers in the surrounding area. He sought out a mentor during his time in Cedara and maintains strong relationships with Cedara staff and surrounding farmers who are willing to help. He is looking to extend his market through these networks. He currently has a cession agreement with a local abattoir but is looking to sell at auctions as well, in the hopes of getting more competitive prices.

Mr. Chonco believes that building relationships with his stock helps him with production. He says that once one gets to know the pigs and their personalities, one can easily tell when one of them is not feeling well, that way help can be provided quickly. His belief in this concept is evident in how he has named every member of his breeding stock (Figure 3.8). Mr. Chonco's pigsty has no electricity, no running water, and limited space; this is restricting his ability to expand production, he says this is his greatest challenge.





Figure 3.8 "Big Mama", one of Mr. Chonco's prized sows

### *Eastern Cape: Matatiele*

Matatiele (Figure 3.9) is a mid-sized town that serves the farming and trading communities of East Griqualand, in the foothills of the western Drakensberg in South Africa's Eastern Cape province, on the border of the KwaZulu-Natal province and just 20 kilometres from Lesotho's southern frontier. The town is part of Alfred Nzo District Municipality, South Africa's poorest district (du Plessis, 2016). The district is located in the north-eastern corner of the province. The district stretches from the Drakensberg Mountains bordering Lesotho down to Bizana in the Wild Coast, covering 10731 km<sup>2</sup>. The district's main economic sectors are community services, wholesale/trade, agriculture, manufacturing, transport and construction (Eastern Cape Department of Rural Development and Agrarian Reform, 2015). Matatiele's main economic activities are agriculture and tourism (Matatiele Local Municipality, 2018).





Figure 3.9 Market Street, Matatiele

Semi-structured interviews were conducted with two respondents in the Matatiele office on the 21<sup>st</sup> of May 2018. The respondents were Ms. Nongogo, the facilitator, and Mr. Magadla, a cattle farmer. Ms. Nongogo started working in the Matatiele office in October 2016, coming in on a transfer from another province. She is 32 years old, has a Diploma in Agriculture (crop production) and has barely used the application outside of the training session as she was just coming back from parental leave. Mr. Magadla is a 59-year-old former school principal who farms with cattle, about 24 kilometres outside of the town of Matatiele. He visited the office looking to join Lima and be registered as part of their farmer support program. Mr. Magadla resigned from teaching to follow his life-long passion of farming, he is currently rearing his cattle on communal land but is looking to get private land, even if on a lease or possibly joining other small-scale farmers at a cattle post.



Figure 3.10 Some of Mr. Magadla's cattle

#### *Eastern Cape: Bizana*

Bizana is a small rural town in the south-east part of the Eastern Cape province; it is located in what is known as South Africa's Wild Coast. The area is the birthplace of South African struggle icons Oliver Tambo and Winnie Madikizela-Mandela. The area falls within the impoverished Alfred Nzo District Municipality. The main economic activities in this area are agriculture, fisheries and tourism.

Semi-structured interviews were conducted with five respondents in the Bizana office on the 22<sup>nd</sup> to the 24<sup>th</sup> of May 2018. The respondents were Mrs. Njeya, the facilitator, Mr. Zondo, Mr. Armstrong, Mrs. Qwathekana and Mr. Dlamini, the farmers. Mrs. Njeya is 50 years old, she completed secondary school education and said she was the last person to start using the application. Mr. Zondo is a 65-year-old poultry farmer. He sells his produce at government grant payment points; he produces an average of 275 chickens per batch. He owns an advanced smartphone.

Mr. Armstrong is a 42-year-old fisherman who catches crayfish and farms with pork and poultry. He is the chairperson of his district's farmers' association and advocates for the improvement of the lives of smallholders. Mr. Armstrong grew up in a fishing family, and he continues to transfer the knowledge he has accumulated over the years to his community. He currently oversees the operations of his farm while his family takes care of the administrative duties. Mrs. Qwathekana is a 67-year-old farmer who farms amadumbe and bananas on her own plot. She is also a member of a women's cooperative which plants amadumbe and sweet potato. Her production is on a small scale. She sells her produce herself within her village. Mrs. Qwathekana did not understand what mobile applications are.

Mr. Dlamini is 35 years old; he farms with sweet potato and amadumbe, he has 8 -12 hectares on communal land, which he can expand as far as he likes given it stays under agricultural production. He employs 12 permanent staffers and sells his produce to street vendors at the market in Durban. Mr. Dlamini has no interest in supplying to the supermarkets because he is too small to be a price maker. Instead, he has decided to expand his production so that he captures a bigger portion of the Durban market. He says his demand at the current market is constantly growing and he is trying to get a permit to have a permanent spot at the Durban Fruit and Vegetable Market.

#### *Eastern Cape: Lusikisiki*

Lusikisiki is a town in the OR Tambo District. This 12096 km<sup>2</sup> district covers about 80% of what used to be the marginalised Transkei homelands (Stats SA, 2011). Lusikisiki's main economic activities are farming and tourism. The Lima office in Lusikisiki is one of the biggest, it is centrally located and has a shade-net nursery in which they propagate seedlings.

Two semi-structured interviews were conducted with respondents in the Lusikisiki office on the 11<sup>th</sup> of June 2018. The respondents were Mr. Madikizela, the facilitator, and Mr. Mhlakaza, his assistant. Mr. Madikizela is 55 years old; he has a Diploma in Agriculture from Lovedale College, a National Certificate in Literacy in Education, a National Certificate in Education and a Certificate in Motor Engineering.

He has highly educated children and owns a smartphone. Mr. Mhlakaza is 33 years old and he did not complete his secondary school education. He started as a Master Farmer and was promoted to assistant facilitator. He assists Mr. Madikizela with some of the office work and has been using the application since its introduction into their office.



Figure 3.11 A shade tunnel in Lusikisiki used for propagating seedlings

### *Mpumalanga*

The contrasts between the climate of the dry Highveld with its cold winters, and the hot, humid Lowveld allow for a variety of agricultural activities to take place within the Mpumalanga province. Approximately 68% of the province is used for agriculture; sorghum, maize, sugar cane, cotton, and tobacco are some of the crops grown here. Forestry is big in the province, particularly in the Sabie region where one of South Africa's largest paper mills is located. Approximately 14% of Mpumalanga is covered by natural grazing; this is used for beef, mutton, wool, and dairy production. Extensive mining is done within this province, the minerals found here include cobalt, copper, and manganese, gold is also mined in the Barberton area. Mpumalanga accounts for 83% of South Africa's coal production. Agriculture and mining are the most significant contributors to Mpumalanga's economy (Stats SA, 2011).

Three facilitators from the Mpumalanga province were interviewed telephonically due to the province being distant. The first respondent, Mr. Ngcobo, is 45 years old, works in Nkomati and

has a Bachelor of Sciences in Agriculture. The second respondent, Mr. Tshivombela is a 31-year-old BSc. Agriculture graduate who services the Mopani region. The last respondent, Mr. Maja is 40 years old, works in Bushbuckridge and has a Bachelor of Technology in Agricultural Extension.

### 3.4 Dependent variables

The study has two dependent variables for farmers, and one for facilitators. For farmers, the first dependent variable measures their acceptance of the application as a secondary user, with the facilitator as the primary user. The farmers' application is not yet available, and there is no measure for farmers' secondary use of the facilitators' application. Therefore, inferences on farmer acceptance and intention to use will be made based on data collected from interviewing both farmers and facilitators. These inferences will help guide recommendations for the development of the farmer application.

For facilitators, the dependent variable is the level of use of the mobile application. Facilitators' level of use will be determined using information gathered by the Reporter. The application continuously records numerical 'info-items' as it is being used. These info-items are then translated and stored by its Reporter as meta-data measuring the number and nature of changes facilitators have made using the application.

The Reporter aggregates data for geographical sites. In most cases, a site is equivalent to a facilitator as there is seldom more than one facilitator per site. Levels of use will be benchmarked against a common base - the minimum number of assessments that facilitators are expected to make for a broiler chicken enterprise. This enterprise is common to all sites (facilitators) and, being a recurrent rather than a seasonal enterprise, is supposed to be assessed by facilitators every quarter throughout the year. Percy Maja, a facilitator in Bushbuckridge, said, "If you are a poultry farmer or vegetable farmer, I need to see you every three months. We need to monitor progress across a production period." Since the application was introduced to some sites earlier than others, the actual number of assessments per site (facilitator) will be measured over the

most recent six-month period, 1 January 2018 to 30 June 2018. During this time each facilitator should have assessed every broiler enterprise twice.

Table 3.3 outlines the process used to compute a comparable level of use at each site. First, the proportion of broiler chicken enterprises will be established for each site. The answer will then be multiplied by the number of active clients and then multiplied by two to give the minimum expected number of assessments. Each site's recorded number of assessments will then be divided by the expected number of assessments to measure levels of use.

Table 3.3 Determining level of use for each site

Site	Active clients (a)	Proportion broilers (b)	Expected assessments (c) = (a) x (b) x 2	Actual assessments (d)	Level of use (d)/(a)
Bizana North	266	0.22	117	144	1.23
Mopani	105	0.06	13	13	1.00
Nkomati	267	0.09	48	44	0.92
Lusikisiki	223	0.08	36	29	0.80
Ixopo	282	0.17	96	75	0.78
Estcourt	283	0.16	91	17	0.19
uMzimkhulu	183	0.41	150	26	0.17
Matatiele	249	0.27	134	18	0.13
Maloti	191	0.52	199	10	0.05
Bergville	303	0.40	242	8	0.03
Bushbuckridge	176	0.09	16	0	0.00

### 3.5 Data analysis strategy

Data analysis was conducted according to the qualitative analysis strategies recommended by Yin (2015, pp. 185-216). Digital recordings of all interviews were transcribed and combined with related field notes, observations and secondary data using NVivo. These transcribed data were then grouped into themes suggested by the theoretical propositions.

These arising themes were then analysed using Yin's (2003, p. 111-115) 'pattern matching' and 'explanation building' techniques. This process tests theoretical propositions by matching them to patterns observed in the data. The proposition is accepted if the observed data patterns are consistent with theory. If the patterns predicted by theory are supported by the data, the validity of the conclusions drawn increases (Tellis, 1997). However, if the data do not support a proposition, they are examined to explain the lack of consistency or to build an alternative theory. It is therefore important that the Researcher entertains rival explanations throughout the analysis process (Yin, 2015, p. 233).



## 4 Results and Discussion

### 4.1 Introduction

This chapter draws on the data collected as described in Chapter 3 to test the propositions stated in Chapter 2. The propositions relate the level of application use with application characteristics and some theorised determinants of intention and use behaviour. This chapter examines facilitators' level of application use and explores relationships between application use and theorised moderators and determinants of use. These findings are then used in conjunction with data gathered in the study to draw inferences about the possible uptake of a modified version of the application by lead farmers.

Venkatesh et al. (2003) theorised that the following four constructs play a significant role as direct determinants of intention and use behaviour relating to information technology: performance expectancy, effort expectancy, social influence and facilitating conditions. These four constructs are in turn moderated by a prospective user's gender, age, experience and voluntariness of use. In this study, it was proposed that education, farming type, and scale would also have a moderating effect on the direct determinants of intention and use behaviour.

Table 4.1 presents facilitators' perceptions of the application and the conditions surrounding its use. The table is divided into two parts with high-use facilitators in the top half and low-use facilitators listed in the bottom half. Facilitators' perceptions are classified as 'low,' 'moderate' or 'high.' The classifications were based on responses to questions characterising the key determinants of intention and use behaviour. For example, performance expectancy is defined as, "the degree to which an individual believes that using the system will help them to attain gains in job performance" (Venkatesh et al., 2003, pp. 447). Therefore, where the response is 'low,' the facilitator felt that the application would do little to help them achieve gains in job performance. The questions were asked in relation to the facilitators' initial perceptions about the application. Therefore, imperfect recall may be a factor as some facilitators had been using the application for up to two years.



Table 4.1 Comparing facilitator level of use with determinants of use behaviour

<b>Facilitator</b>	<b>Performance expectancy</b>	<b>Effort expectancy</b>	<b>Social influence</b>	<b>Facilitating conditions</b>	<b>Use classification</b>
Mrs. Njeya	Moderate	Low	High	High	High
Mr. Tshivombela	Moderate	High	High	Moderate	High
Mr. Ngcobo	High	High	High	Moderate	High
Mr. Madikizela	High	High	Low	High	High
Mr. Mhlakaza	Moderate	High	High	High	High
Ms. Mncwabe	High	High	Moderate	High	High
Mr. Mathunjwa	High	Moderate	Low	High	Low
Ms. Ngcobo	High	High	Moderate	High	Low
Ms. Nongogo	Moderate	Moderate	Moderate	High	Low
Mr. Buthelezi	High	High	Moderate	High	Low
Mr. Maja	High	High	Moderate	High	Low

Table 4.2 compares farmers' intention to use the proposed application and acceptance, as a secondary user, of the current application to the key determinants of intention and use behaviour. The levels of intention and acceptance reflect farmers' responses to questions about their openness to using the mobile application proposed for master farmers, and how open they were to using the facilitators' application as secondary users.

The individual determinants of intention and use behaviour, both for farmers and facilitators, are analysed in Section 4.4. Sections 4.2-4.3 examine relationships between personal attributes and level of application use, measured (a) for the application as a whole, and (b) for each of its functions.

Table 4.2 Comparing farmer intention and acceptance with determinants of use behaviour

Farmer	Performance expectancy	Effort expectancy	Social influence	Facilitating conditions	Secondary user acceptance	Primary user intention
Mr. Magadla	High	Low	Low	Moderate	Enthusiastic	High
Mr. Chonco	High	Low	Low	Moderate	Enthusiastic	High
Mr. Dlamini	High	Low	Low	Moderate	Enthusiastic	High
Mr. Zulu	High	Low	Low	Moderate	Acceptance	High
Mrs. Qwathekana	Low	High	Moderate	High	Enthusiastic	Reserved
Mrs. Mavuma	High	Moderate	Low	High	Enthusiastic	Reserved
Mr. Zondo	Moderate	Moderate	Low	High	Acceptance	Reserved
Mrs. Ntuli	High	Low	Low	High	Acceptance	Reserved
Mr. Armstrong	Moderate	Low	Low	Moderate	Indifference	Reserved
Mrs. Jili	Low	High	Low	High	Indifference	None
Mrs. Mchunu	Low	Moderate	Moderate	High	Tentative	None

## 4.2 Level of use

This section uses the comparable measure of use computed in Chapter 3 to classify facilitators into two groups; those with a relatively high level of use, and those with lower levels of use. Two of this study's four objective relate to the application's level of use. Table 4.3 compares the application's level of use with facilitator attributes. It should be noted that Lusikisiki has two facilitators working at the same site. Both were interviewed, and the lack of facilitator-level use data was considered when the data were analysed. It should also be noted that Mr. Buthelezi works in two sites, Maloti and Bergville. Levels of use computed for these sites were very similar lending support to the method used to measure facilitators' levels of application use.

Table 4.3 Facilitator attributes and level of application use

Facilitator	Site	Age (yrs.)	Gender	Education	Experience		Level of use
					Lima app (months)	all apps	
Mrs. Njeya	Bizana North	50	Female	Secondary	3	Low	1.23
Mr. Tshivombela	Mopani	31	Male	Bachelor's	8	Moderate	1.00
Mr. Ngcobo	Nkomati	45	Male	Bachelor's	7	Moderate	0.92
Mr. Madikizela	Lusikisiki	55	Male	Diploma	24	Moderate	0.80
Mr. Mhlakaza		33	Male	Secondary	24	Moderate	
Ms. Mncwabe	Ixopo	27	Female	Bachelor's	12	High	0.78
Mr. Mathunjwa	Estcourt	32	Male	Diploma	7	Low	0.19
Ms. Ngcobo	uMzimkhulu	25	Female	Diploma	12	High	0.17
Ms. Nongogo	Matatiele	32	Female	Diploma	1 week	Moderate	0.13
Mr. Buthelezi	Maloti	28	Male	Bachelor's	7	High	0.05
	Bergville						0.03
Mr. Maja	Bushbuckridge	40	Male	Bachelor's	7	High	0.00

From Table 4.3, it can be seen that the high-level users are generally older and with marked variation in education when compared with low-level users. The average ages of high and low-level users are 40 and 31 years respectively. This finding does not match the pattern predicted by theory, where high-level users are expected to be younger. On the other hand, the higher incidence of bachelor's degrees in the high use group appears to support propositions that education does matter. However, this quantitative univariate analysis ignores the problem of small sample size and fails to capitalise on the study's purposive sampling design which allows for in-depth qualitative analysis based on comparisons between cases similar in all respects apart from the attributes under scrutiny. The following section, therefore, uses the study's design to

conduct an in-depth qualitative analysis of the identified facilitator attributes and how they influence the level of application use.

### *Site*

It was expected that facilitators located closer to Lima's head office, and therefore support services, would make greater use of the application. However, this proposition, relating to facilitating conditions, was not supported by the data. Mr. Buthelezi and Mr. Tshivombela are similar in respect of age, education, and experience with the application, but work in different provinces. Mr. Buthelezi's site, Bergville, is 154 kilometres from Lima's head office while Mr. Tshivombela's site, Mopani, is 954 kilometres away. Despite this disadvantage, Mr. Tshivombela makes much more use of the application than does Mr. Buthelezi. A possible explanation for the mismatch between the proposition and the findings is that the application is being used alongside other applications that alleviate the distance problem.

*"We make use of TeamViewer if we are having issues with laptops or tablets, the developer or someone at the head office's IT department helps remotely."*

Ms. Nongogo, Facilitator

Other factors that may explain this unexpected result may be the reliability of the local electricity supply and network services. Facilitators in areas where there is poor network signal and erratic electricity supply may display low levels of application use because the application requires an internet connection for full functionality.

### *Age*

To investigate the effect of age on level of use, the level of application use of Mrs. Njeya was compared to that of Ms. Ngcobo. The older Mrs. Njeya's level of use was observed to be higher than Ms. Ngcobo's. Mrs. Njeya, who is Ms. Ngcobo's senior used the application more. The same comparison was made between Mr. Ngcobo and Mr. Buthelezi, both male facilitators, with the same level of education, working in similar sites. This comparison provided a similar finding. Mr.

Ngcobo, the older facilitator, had a higher level of use than Mr. Buthelezi. These findings do not support the theory that younger facilitators would make greater use of the application. A possible explanation for this is that, according to the UTAUT model, age is not a direct determinant of application use behaviour. Age interacts differently with other factors influencing intention and use behaviour. Therefore, what this finding suggests is that age may be positively correlated with other drivers of application use.

### *Gender*

Two pairings of facilitators were chosen to investigate how gender influences the level of use. Mr. Buthelezi and Ms. Mncwabe are the same age, of the same education background, working in similar areas. Theory suggests that there would be a difference in the level of use between genders. From analysing their pairing, it was found that Ms. Mncwabe had a significantly higher level of use. To investigate whether the same is true at an older age, as gender and age often interact, a second pairing comparing Mr. Madikizela's level of use with Mrs. Njeya's level of use was examined. A similar result was found as Mrs. Njeya had a higher level of use than Mr. Madikizela. The qualitative analysis supports the proposition that levels of use differ between males and females and shows a higher level of use by females.

### *Education*

To determine how education influences use behaviour, Mr. Tshivombela's level of application use was compared with Mr. Mathunjwa's. Mr. Tshivombela, being more educated than Mr. Mathunjwa, was expected to have a higher level of application use. This was indeed the case. The same variable was investigated using female facilitators. Similarly, when Ms. Ngcobo and Ms. Mncwabe's level of use was compared, it was found that the higher educated Ms. Mncwabe had a higher level of use, as expected. These findings support the proposition that better-educated facilitators will tend to have a higher level of use.

### *Experience*

The data do not provide sufficient evidence to support the theory that a greater level of experience with the Lima application will lead to higher levels of use. Ms. Ngcobo and Ms. Nongogo are facilitators with similar attributes, differing only in experience with the application. It was expected that Ms. Ngcobo, having had more experience with the application would have a significantly higher level of use. However, this was not the case; there was only a marginal difference between the two facilitators' level of use.

The investigation into facilitators' general experience with applications revealed that facilitators with less experience using mobile applications displayed higher levels of Lima application use. For example, Mr. Maja who is classified as being highly experienced with mobile applications in general has a lower level of use than Mr. Ngcobo who is only moderately experienced. The same pattern is observed between Mr. Tshivombela and Mr. Buthelezi. This finding is not in line with what theory proposes. A possible explanation for this is that experience, like age and other attributes, is not a direct determinant of application use behaviour. Experience interacts differently with other factors influencing intention and use behaviour. Therefore, what this finding suggests is that experience may be negatively correlated with other drivers of application use.

In terms of the UTAUT model, these personal attributes are not viewed as determinants of use behaviour but rather as moderators of the direct determinants of intention and use behaviour, where the direct determinants are performance expectation, effort expectation, social influence and facilitating conditions. Another moderator of the direct determinants of use is voluntariness of use. This variable could not be tested amongst the facilitators as they were all obliged to use the application. However, voluntariness did apply to the sample of farmers and is analysed later with the direct determinants of intention and use behaviour.

### 4.3 Application usability and use of application functions

To establish what characteristics and functions are desired in an application designed to aid extension, this study investigated the application's usability based on its characteristics, whether facilitators used certain functions of the application more than others, and what distinguished the most frequently used functions from others.

#### 4.3.1 Application usability

There are seven attributives which reflect the usability of an application: effectiveness, efficiency, satisfaction, learnability, memorability, errors and cognitive load (Harrison et al., 2013). This section investigates the usability of Lima's Farmer Support Application according to these themes. The section also investigates the application's demand and ease of use and based on these three areas, makes recommendations on how improvements can be made to the existing application and implemented in the development of the proposed application.

##### *Effectiveness*

Application effectiveness is the ability of a user to complete a task in a specified context. In this case, a facilitator being able to register a farmer fully would be an example of a measure of the application's effectiveness. For the most part, facilitators found the application to be effective as they were able to use it to complete tasks.

*"The application covers almost everything I need to collect information as a facilitator; I can use it for co-op registrations, farmer registrations, assessments and so forth."*

Mr. Buthelezi, Facilitator

While most of the application's functions helped facilitators to perform their tasks, the workers' registration function was perceived to be less effective.

*“I still struggle with this one, now and then it gets stuck. Say for instance I want to add a worker for Mr. Zondo here, sometimes it refuses to link so I have to write the names on the side and then go to my regional manager and ask for help”*

Mrs. Njeya, Facilitator

The occasional malfunctioning of the workers’ registration function has contributed to it being the least used function on the application and thus reduces the effectiveness of the application. To improve the effectiveness of the application, developers need to debug the application regularly to ensure that all application functions work well.

### *Efficiency*

Application efficiency is the ability of the user to complete their task with speed and accuracy. This attribute measures the user’s productivity while using the application and can be measured in ways such as the number of keystrokes required to complete a task. The Lima application developers pride themselves in having created an application that reduces facilitators effort in performing their tasks. However, while the application eliminated the tedious task of filing registrations and assessments associated with the old paper-based system, its efficiency could be improved.

As part of the study, the researcher observed some facilitators using the application. The researcher noted that the application’s home page had small print, it was prone to hanging, had a relatively slow response time and completing tasks took more time than was expected. Some facilitators, like Mr. Mhlakaza, echoed these sentiments.

*“It does take some time when you are on the field. Currently, when I do assessments, I take between 30 -45 minutes with one client, whereas when I was doing it by hand, it would take around 15 minutes.... For me, it is simply much easier to write than having a lot of drop selections, and places to select instead of merely ticking. Those are the things that make the process a little slow. Otherwise, it is really easy to use.”*



Mr. Mhlakaza, Facilitator

The developers could improve the efficiency of the application by increasing the home page font so that features are easier to see, and the tabs are bigger, thus reducing tapping errors. They should also reduce the number of dropdown entries and include a search function to improve navigation.

### *Satisfaction*

Application satisfaction refers to the perceived level of comfort and pleasantness afforded to the user by the software. The facilitators offered mixed reviews on how they felt about the application but agreed that it was superior to the paper-based system.

*“I am very happy with the app just the way it is. We raised some issues it had during the beta phase and they fixed those, I think it is good. “*

Ms. Mncwabe, Facilitator

*“The assessment needs to go with the crops that we are working with here. Currently, some of the things on the tablet are not what we want on the system. Some of the questions asked are not aligned with our farmers’ cropping methods. I think they were supposed to look at old assessments and look at what kind of questions had been done previously and incorporate that onto the app.”*

Mr. Tshivombela, Facilitator

The consensus on the application being an improvement on the previous system signals its value as a useful intervention. There is also evidence of developers’ effective response to feedback; this is a good foundation for user satisfaction. This study recommends that developers should involve end-users in the development of applications to improve relevance and compatibility. They should also request regular feedback from users and act on it. In an agricultural context, feedback on relevance is essential since developers are often unaware of the unique circumstances of farmers and extension workers.

### *Learnability*

Learnability refers to the ease with which a user can gain proficiency with an application. Many facilitators said they found learning the overall use of the application to be an easy task. The application uses Adobe Acrobat Reader, another application, for some of its functions. Facilitators stated that they found navigating between the two applications challenging.

*“...the signature portion of it really troubled me for a while. Most of the time I would struggle because you have to go from file, then my document, then to pdf, then ok. All along, it worked well for the others, but mine had issues, I would have to leave the farmers tab, go to Adobe, then look for the farmer on Adobe under local and see if they appear there, then tap on the farmer and only then can they sign. For a very long time, I struggled with it.”*

Mrs. Njeya, Facilitator

The developer could find a way to integrate Adobe Acrobat Reader into the application in such a way that it opens automatically when the signature function is opened and merges seamlessly into the Lima application's functionality. This integration would reduce the number of keystrokes necessary to complete a task, save time, and avoid a situation where facilitators feel obliged to become proficient users of another application.

### *Memorability*

Application memorability refers to the ability of a user to retain knowledge of how to use an application effectively. This attribute is based on the assumption that mobile applications are generally used on an infrequent basis. This, therefore, does not necessarily apply to the Lima application as using the application forms part of the facilitators' daily tasks. However, some functions of the application are used more than others due to differences in demand. When asked why she had not used the workers' registration function Ms. Ngcobo said,

*“It is because I have only been here for six months, and in that time, I have not had to use it. However, the facilitator who was here before me has used it on this site “*

Ms. Ngcobo did not think she would struggle with using the function, when the time comes for her to use on her new site. However, Mrs. Njeya, who had used and experienced issues with the workers' registration function had this to say,

*Sometimes it works, sometimes it does not. I am uncertain whether the times it does not work are when I have forgotten how to use it.*

Mrs. Njeya thought that her struggles with the function could be a result of more than just a system bug, that her own memory could be a factor. Mrs. Njeya is older than most of the other facilitators, and this could contribute to her memory. The researcher observed that she struggled most with functions that required multiple keystrokes and having to navigate in and out of files within the application. Therefore, reducing the number of keystrokes required for each function, and making navigation more seamless could help with memorability and encourage task efficiency for older users and those who have not used the function for a while.

### *Errors*

The errors attribute is used to reflect how well the application user can complete the desired task without errors. The facilitators reported making many errors when they started using the application. Many said that as they have grown accustomed to the application, the frequency of those errors has decreased.

*"Sometimes as you were capturing the information, you would mistakenly press the wrong button, and then you must redo the work. We are now used to the application and are working much faster."*

Ms. Ngcobo, Facilitator

*"The work used to go quite slow on the field because now it's something new. Whereas, previously we knew that on the paper you simply tick here and you tick there. On the tablet there are scroll downs, and you have to make sure you are hitting the right button so that you*

*don't have to start afresh. It was really slow during the trials, but as time went on, we got used to it."*

Ms. Mncwabe, Facilitator

Evidence shows that in some cases, errors are not quick to fix, facilitators often have to start over when they mistakenly press the wrong button. It appeared that they deliberately slowed down to avoid making errors. Working slower would result in spending more time with a single farmer and could potentially improve the quality of the data being collected. The decreased error rate could be a result of either the facilitators becoming more accustomed to the application, or their working slowly, more carefully. Developers should include an 'undo' function on the application so that facilitators are not required to start afresh every time they make a mistake.

#### *Cognitive load*

This attribute considers that unlike desktop applications, mobile application use usually includes performing additional tasks such as interviewing. The developer must consider how using the application may influence these additional tasks. Cognitive load refers to the amount of cognitive processing required by the user to use the application.

The researcher observed the facilitators using the application and noted that facilitators would often sit down with their clients when using the application, concentration written on their faces and fingers hovering over the screen, making sure that they touched the right buttons. Use of the application appears to require significant concentration to navigate without making costly errors. The developer should make it easier to use the application by allowing quick access to features and easy navigation. The application should also allow the user to undo errors with a simple tap; this would reduce the amount of pressure on the user to not make a mistake, thus making for a more enjoyable experience.

### *Demand and ease of use*

This study proposed that there will be a difference in the frequency of use of individual application functions. It was proposed that use will be demand-driven, such that the most frequently used functions will be those demanded by the facilitators' tasks. This study found that while demand did influence the use of application functions, ease of use also had an effect.

Lima's work sites have different mandates, depending on whether they are old or new. The focus of new sites is to register a minimum of 1000 farmers. Old sites are focused on servicing the clients they already have. Consequently, there are differences in the use of the registration and assessment functions of the application.

*"I think the one we are likely to use the most because our site is no longer recruiting new farmers, is the assessments and job declarations. We are no longer registering farmers and cooperatives; our focus has shifted to better servicing the existing clients - unless someone comes into the office and shows interest, then we explain to them how everything works, register them, go to their farm to obtain the GPS coordinates and then follow up with visitation."*

Ms. Nongogo, Facilitator, Matatiele

As would be expected, facilitators made greater use of functions relevant to their sites and mandate. It is therefore important to consider the specific needs of the client when developing an application since use is demand driven. Clients will not use a function only because it exists. All facilitators cited the farmer and cooperative registration and assessment functions as the application functions most frequently used. Most of the information compiled on the Reporter was collected using these two functions. Worker registration was the least used function across all sites. Facilitators cited a snag with the function as the reason for its lack of use. The function processed worker registrations but did not always allow the user to link the worker with a farmer who needed more labour.

*“I still struggle with this one, every now and then it gets stuck. Say for instance I want to add a worker for Mr. Zondo here, sometimes it refuses to link so I have to write the names on the side and then go to my regional manager and ask for help.”*

Mrs. Njeya, Facilitator

Moreover, the Programme’s mid-term evaluation (Williams, 2018), reported that the registration of farmworkers has been difficult due to a lack of reliable data from farmworkers themselves. Many farmworkers are employed on a seasonal basis, and their employment status can change from one quarter to the next. Some are unwilling or unable to provide information required by the registration function as they lack formal evidence of their eligibility to work permanently in South Africa. It is therefore important for developers to ensure that all the functions in their application are fully functional and that they consider the social aspects of the environment in which they are expected to work.

#### 4.4 Determinants of use behaviour

Venkatesh et al. (2003) theorised that four constructs play a significant role as direct determinants of intention and use behaviour concerning information technology: performance expectancy, effort expectancy, social influence and facilitating conditions. These four constructs are in turn moderated by gender, age, experience and voluntariness of use. This study proposed that education, farming type, and scale would also have a moderating effect on the direct determinants of intention and use behaviour. These relationships were examined using data drawn from both the facilitator and farmer samples.

##### 4.4.1 Performance expectancy

This section analyses the influence of performance expectancy on behavioural intention and how this influence is moderated by several factors. Lima’s Farmer Support Programme is funded by the Jobs Fund, a National Treasury initiative, and the NGO is obliged to report on the Programme’s progress based on several key performance indicators. Measuring these indicators requires that assessments be conducted on an individual farm basis. In the past, Lima recorded

these assessments on paper, and the data would later be captured in an Excel template and then filed. This process was time-consuming for administrators and reduced the effectiveness of facilitators and managers who spent much of their time collating data for progress reports. Although there are currently plans to include lead farmers as application users, the application was initially designed specifically for the facilitators to make the process of data collection and reporting easier and more efficient.

*“The application was designed very much with the understanding, and this is really our main thesis if you like, that the amount of time and effort spent on the double-handling, paper-based system was onerous and taking huge chunks of time from the facilitators, detracting from the actual core business of extension. So, if you have 8 hours in a day, these guys were spending about 4 hours doing admin.”*

Application Developer 2

The ‘demand-driven’ nature of the application improved performance expectancy. Facilitators attended demonstrations before the official introduction, and they were told that the adoption of the application would improve efficiency and mitigate data loss. Facilitators disliked the amount of filing and data compilation the old system brought at month-end, and most were excited by the prospect of a faster way of completing a tedious task.

*“What we started off with was the individual register. When we had it sorted, we decided that we had to find the least computer literate guy and put it in his hands. So, we went out to Mr. Madikizela and gave it to him, and there was a delay in terms of me having to tweak certain things based on his experience in the field. All the time we were fixing that - it took us about three to four months - there was a constant feed from the managers to say the other guys want it. For me it has been a slightly different project because normally, as the IT guys, we often tell people, ‘we have built this system, make it work’. What we had, in this case, was, ‘we have got the process and the data, make something’, which is a much better way to go.”*

Application Developer 1

There is evidence that facilitators felt that the application would result in gains in performance and that their intention to use the system was influenced by their perceptions of its performance.

*“Our manager told us what they were planning on doing and that they would like to hear what we think. We told her that we would be very happy with it as we were tired of all these papers. It took a while after she had spoken to us before they arrived, and we would constantly inquire about when they were coming because we were really looking forward to them. We were really excited. We saw it as an improvement that we will now be carrying tablets instead of constantly having to travel around with files. Now you know that apart from the tablet the only thing you need to have with you is the farm visit register or the training register, depending on what you are doing that day. Whereas before you had a pile of papers.”*

Ms. Ngcobo, Facilitator

The degree to which this expectancy influences behavioural intention is theorised to be moderated by gender and age, with younger men expected to place more saliency on performance expectancy when deciding to use a system. The theory that men place more value on performance than women is based on empirical evidence indicating that men are highly task oriented. Gender theory suggests that this task orientation is not linked to biological gender but rather to gender roles and socialisation processes reinforced from birth (Lynott & McCandless, 2000).

Over the years, society has become more fluid on gender roles, and this has introduced an age aspect to the influence of gender on performance expectancy. Younger people are likely to have grown up in a society with less defined gender roles, and this may affect how performance expectancy influences their behavioural intention. The interaction of gender and age is apparent in this study. When asked about his initial opinion on the application, Mr. Madikizela, the oldest male facilitator said:



*It appealed to me because using papers would often lead to papers being lost, however now that we have this tool, information can almost be immediately saved at a central place and even if I were to lose the tablet, I would be able to retrieve that information from the developer.*

Mr. Madikizela, facilitator

For Mr. Madikizela, the expectation that the application would improve the efficiency of how he carried out his job was integral to forming his intention to use the application. In contrast, Mrs. Njeya, the oldest female facilitator initially felt that the application was a tool which had been given to her by her employers. Therefore she had to use it.

Amongst the younger facilitators, males and females equally valued performance expectancy in their decision to use the application. For example, Mr. Buthelezi, Ms. Mncwabe and Ms. Ngcobo who are of similar age all mentioned performance gains as a key determinant of their intention to use the application. All three facilitators spoke of how they eagerly anticipated the rollout of the application as they expected it to improve their operations significantly. These observations show how gender is becoming less significant as a moderator of relationships between performance expectancy and behavioural intention as society is becoming more fluid on gender roles.

One of the weaknesses associated with the UTAUT model is highlighted in the relationship between performance expectancy, behavioural intention, and use. UTAUT fails to bridge the intention-actual behaviour gap and considers intention as being representative of actual use. According to Bagozzi (2007), there is a lapse between intention and actual use. A person's intention could be subjected to evaluation and reflection which might direct the person to reformulate their intention, which may lead to their taking a different course of action. While in this study there could be no deciding against the use of the application as it was mandatory, there is evidence of user evaluation and reflection on the application's performance.

Mrs. Njeya, who had initially formed her intention to use the application based on social influence, reformulated her intention to use the application based on its performance after observing other users.

*I was the last one to get this app, after having seen others use it, and I saw them progress with it. I then desired it because I perceived a difference in the work they were doing, it appeared that they were working much easier.*

Mrs. Njeya, Facilitator

On the other hand, Ms. Ngcobo and Mr. Buthelezi who had high expectations of the application's performance found that it did not measure up. The actual application paled in comparison to what they expected; this may have influenced their actual use of the application. Under voluntary conditions, a user would stop using an application if they are not satisfied with its performance. The case of Mr. Dlamini, one of the farmers, is an example of this.

*I once downloaded an application called Farm Africa but realised that the information there is mostly based on countries outside of Southern Africa, I think it was West and East African countries. I could not find much use in it, so I deleted it. It also did not suit my farming level.*

Mr. Dlamini, Farmer

Under mandatory conditions, the user may either begrudgingly use the application or try to influence its improvement. Several facilitators cited issues with the performance of the workers' registration function of the application, and some elected not to use it. Mr. Buthelezi and Ms. Ngcobo made explicit recommendations to improve application performance.

*I would just like to see some changes in the way it works; a new interface would be nice. Also, I would like to see an improvement in navigating around the app, like adding a search button, so that I do not have to manually look for the farmer I want.*

Mr. Buthelezi, Facilitator

*“I would also like to be able to view all the information of the farmer when I go onto their page. I would really like an improvement on the layout of the app. ... I would like to press on a farmer’s name and have their full profile show, what they farm in, average income, what kind of training they have, what do they still need to be trained in, do they have a loan out from us and so on.”*

Ms. Ngcobo, Facilitator

Ms. Ngcobo and Mr. Buthelezi’s performance expectancy and later, disappointment and recommendations, can be traced back to their experience with mobile applications in general. Their experience with sophisticated mobile applications raised their expectations of the application and they demanded more of it than did Mrs. Njeya who had less experience. For older users, gender may well condition experience. Experience requires access, and evidence from South Africa shows that, historically, women had less access to ICTs than did men (Thlabela, 2006).

This study found performance expectancy to be a significant determinant of behavioural intention amongst facilitators and farmers. The effect of performance expectancy on behavioural intention was found to be moderated by experience such that users with more experience will have higher performance demands, and place more importance on performance when forming intentions to use the application. Experience with mobile applications was found to be influenced by age and gender such that younger males were likely to have more experience. Contrary to the UTAUT model, this study highlights a link between performance expectancy and actual use. Initial performance expectancy may inform user intention, but this is subject to review and feedback which may affect the level of use even when use is compulsory.

#### 4.4.2 Effort expectancy

No obvious difference in use behaviour was observed between facilitators who associated the use of the application with a low degree of ease and those who associated it with a high degree of ease. Therefore, consistent with theory, effort expectancy does not directly influence use behaviour. However, it does influence behavioural intention. Little variation was observed in facilitators' effort expectancy. Most expected the use of the application to be easy, mentioning that they had been using a similar system on paper and then on their laptops before the mobile version was introduced.

*“Initially we were using a paper-based system but with the same concept. The tablets were introduced later, and it was easy for us to move onto them because we were doing the same thing we did on paper on the tablets. Nothing was really challenging with the system.”*

Mr. Mhlakaza, Facilitator

The progression from paper to laptop and finally to a mobile application was mentioned often as one of the factors contributing to the level of ease associated with using the system. The gradual progression meant that some level of familiarity and experience was built along the way, and longer-serving facilitators viewed the application not as an entirely new system but as a modification of something they had already adopted.

*“The introduction was back when I was still an intern, but back then they were on the laptop. For us to work faster they introduced the application onto the tablet. Now that it's on the tablets it's easier for me to even update information there and then and to even capture coordinates. The format is the same, so it made the transition easier.”*

Mr. Buthelezi, Facilitator

Only three of the eleven facilitators interviewed expected the use of the application to require moderate to high effort. These three facilitators were Mrs. Njeya, Mr. Mathunjwa and Ms. Nongogo. Mrs. Njeya expected the use of the application to require a high degree of effort. She

perceived the technology to be of a *'high standard'* and displayed signs of anxiety when using the application. Mrs. Njeya's anxiety and her effort expectancy level could be a result of a lack of experience with mobile applications in general. Although Mrs. Njeya owns a smartphone, she does not use it for much beyond calling, texting and using WhatsApp messenger. The same relationship between general experience with mobile applications and effort expectancy is displayed by Mr. Mathunjwa. Mr. Mathunjwa was the only facilitator who did not own a smartphone and he rated himself as *'not a technology person'*. His lack of experience with mobile applications could explain why he perceived higher effort expectancy than Mr. Mhlakaza, his less-educated contemporary.

Ms. Nongogo's concerns about effort expectancy did not relate to her ability to use the application but rather to other issues surrounding its use. Once again, this highlights the role of experience with other mobile applications or related systems. Ms. Nongogo's misgivings about the effort needed to use the application were those of someone familiar with mobile applications and aware of their limitations.

*"I was first worried that the tablets would create extra work for us, such as having to remember to regularly charge them as we do with our personal cell phones because you cannot work if it's off. Even though it is not your phone, you need to have that thing that it must be ready so that I can do my job. Secondly, we experience network problems quite often here in Matatiele and this works using the Vodacom network and not satellite. It is therefore sometimes difficult to capture everything on the field. I worried whether this would only make our jobs more difficult, or if it will lighten the load. I also worried about the tablet being stolen or broken, this would mean losing the work we have compiled. That means having no backup, whereas pieces of paper can be photocopied."*

Ms. Nongogo, Facilitator

Ms. Nongogo mentioned that she had no doubts about her own ability to use the application, citing previous experience with computer systems as a moderator for her effort expectancy.

*"I have been using a laptop since I was in tertiary education so navigating through everything is similar to using a regular computer, just in a compact form."*

Ms. Nongogo, Facilitator

The results suggest that the more experience users have with mobile applications and related systems, the less their effort expectancy will be. Supporting this finding were observations amongst the farmers. Farmers who had little to no previous experience with mobile applications and related systems had a high effort expectancy and it influenced their intention to use the proposed application significantly. Mrs. Jili, for example, used her mobile phone only to send and receive calls and text messages. When asked if she would consider using a mobile application she replied: *"I do not think I can do that!"*.

The facilitators provided further support for the effect of general mobile application experience on effort expectancy. When asked why some farmers would find the proposed application easy to use while others would find it challenging, facilitators attributed the perceived ease of use to prior experience with mobile applications and computers. This response is consistent with the view that ICT skills are, for the most part, transferable. Competency in one system often reduces the effort necessary to use another (Ashcroft, 2004).

According to Venkatesh et al. (2003), age and gender also influence effort expectancy such that it will be higher for older women. In this study, Mrs. Njeya - the oldest female facilitator - did indeed have the highest level of effort expectancy. To test this theory, two facilitators who share similar personal characteristics other than age were compared. Ms. Ngcobo's effort expectancy was compared with that of Ms. Nongogo. Ms. Nongogo, the older facilitator, had moderate effort expectancy, while the younger Ms. Ngcobo had low effort expectancy. This finding is consistent with Venkatesh et al.'s theory that age is a moderator of effort expectancy. However, when a similar test is conducted amongst the male facilitators, comparing Mr. Ngcobo and Mr. Buthelezi, no observable difference is found between the two facilitators' effort expectancy. This suggests the effect of age on effort expectancy may be more apparent for females than males. A similar observation was made amongst the farmers. While there was no discernible pattern in the

relationship between effort expectancy and age amongst male farmers, older women displayed higher levels of effort expectancy than younger women. This difference correlated strongly with lower intentions to use the proposed application suggesting that older female farmers will be less likely to adopt the application owing to high effort expectancy.

Several studies have examined the effects of gender and age on effort expectancy as separate variables, but few have looked at how they interact. In a study conducted on a group of grades 7, 9 and 11 learners, King et al. (2002) found that girls in grade 7 experienced the highest levels of computer anxiety amongst the females, whereas boys in grade 11 displayed the highest levels of anxiety amongst the males. The study suggests that the reason behind the age difference is that males consider a computer to be a toy while females consider it to be a tool. King et al. (2002) suggest that in the early stages of a girl's life she has little use for the computer because unlike the boy, she is generally not playing computer games. However, at an older age, she begins to use it for her academic work and then for female-dominated administration jobs. Since anxiety is a construct of effort expectancy, what can be deduced from the King et al. (2002) study and observations from the current study is that experience appears to be the more significant moderator of effort expectancy while age and gender determine when and to what extent this experience is obtained.

In line with theory, this study found effort expectancy to be a determinant of intention to use the mobile application. However, due to the mandatory nature of the application's use, it did not affect actual use. Experience was found to influence this relationship such that the influence of effort expectancy on behavioural intention is more salient for individuals who have less experience with mobile applications or computing systems.

#### 4.4.3 Social influence

As noted previously, Lima must submit a monthly progress report to the Jobs Fund. Continued funding for Lima's smallholder development work requires strict compliance with these reporting obligations. South Africa suffers a high rate of unemployment (Stats SA, 2018). Employees value their jobs and have a strong incentive to be perceived as high performers. For these reasons, it

was anticipated that social influence would be a significant determinant of behavioural intention and, possibly, use behaviour amongst facilitators.

Indeed, the study found social influence to make a visible contribution to facilitator behavioural intention. Most facilitators did not question the introduction of the application. Many referred to it as the 'tool' that had been 'handed' to them by their employer to help carry out their tasks.

*"The app was handed over to us to use by Lima. The company determines the tools we use to service the farmers. We just follow the instructions we have been given."*

Ms. Nongogo, Facilitator

Social influence appears to be one of the most significant determinants of both use behaviour and behavioural intention, as the level of use appears to match the importance of social influence expressed by each facilitator. Facilitators who attached high importance to the way their employers or seniors viewed their productivity also had the highest level of application use. For example, Mrs. Njeya found the application challenging but recorded the highest level of use as she felt duty-bound to use it. She displayed a high level of deference to authority, using words like 'mphathi' and 'mphathi omkhulu' which mean manager, master or overseer instead of using the names of her supervisors like the other facilitators did.

*"Honestly, we had already gotten used to the way we were doing things, and it was working for us. That is not to say the app was unnecessary, but since this was introduced, and the employer told us that this is what we are supposed to use, we found it to be okay as well. The reality is that we are being governed. The employer says this is what we have. We, therefore, must use the tool that has been given to us."*

Mrs. Njeya, Facilitator

Her gender could influence the saliency of social influence on Mrs. Njeya's behavioural intention and use behaviour. Theory suggests that women tend to be more sensitive than men to others' opinions and therefore find social influence to be more salient when forming intentions to use new technology. Comparing Mrs. Njeya to Mr. Madikizela - a male of comparable age, education



and experience – there appears to be some support for this theory as Mr. Madikizela scores low on social influence. However, in extrapolating this to all of the other female facilitators, it was found that they displayed lower or equal levels of social influence to their male counterparts.

Mrs. Njeya is older than the other female facilitators and her increased sensitivity to social influence may be attributed to age. However, upon investigating the matched pairs of Mr. Tshivombela (31 years old) and Mr. Ngcobo (45 years old), and Ms. Nongogo and Ms. Ngcobo, this study found no obvious influence of age on the relationship between social influence and actual use.

Another factor that clearly distinguishes Mrs. Njeya from the other female facilitators is that she is less educated. The importance attached to social influence by Mrs. Njeya appears to have more to do with her education than with her gender or age. Further support for this theory is provided by the case of Mr. Mhlakaza who also attached high importance to social influence and was the only other facilitator with no tertiary education. In fact, Mr. Mhlakaza did not complete secondary school. He started working with Lima as a lead farmer and performed so well that he was promoted to an intern/assistant facilitator. During the study, he was cited as being personally responsible for the high level of application use within the site.

While findings reported in the literature on this matter are mostly inconclusive, there is still a common perception that people with higher levels of formal education perform better at their jobs and therefore enjoy greater job security (Ariss & Timmins, 1989). If Mrs. Njeya and Mr. Mhlakaza recognise that there is this perception of higher education being linked to better job performance, they have the incentive to prove otherwise to ensure the security of their jobs. Understanding this perception could provide greater incentive for Mrs. Njeya and Mr. Mhlakaza to impress their employers by performing well with the tools they have been given.

The relationship between social influence and education was also found to be conditioned by workplace seniority. Two cases highlight this observation, Mr. Madikizela and Mr. Mathunjwa. Mr. Madikizela had worked with Lima for a long time and supervised Mr. Mhlakaza, his less educated assistant who responded strongly to social influence. Seniority allowed Mr. Madikizela

to delegate work involving the application to his assistant. Consequently, he attached little importance to social influence as a driver of application use as it was Mr. Mhlakaza rather than the application that delivered his perceived performance. Similarly, in Estcourt, Mr. Mathunjwa had previously used an intern to do most of the work on the application and did not make much use of the application himself until the intern was promoted.

*“Even though I am not the kind of guy who is into this, I am not very good with technology. However, it was not that bad. I had an intern at that time; he has now been promoted. He was doing all that stuff. I can tell you that I only learnt last week how to do a screenshot. I am not the kind of guy who is good with technology...”*

Mr. Mathunjwa, Facilitator

Among the farmer respondents, something different was observed. Farmers who witnessed other individuals using and benefiting from a new application were more likely to review the application and establish performance and effort expectations for it.

*“I have not always been “current” regarding technology, but my kids put me on to these things. My daughter would complain that I do not have internet banking and she must wait for me to go to the bank before she can have money. She showed me how easy it is; now I cannot imagine myself doing things any differently.”*

Mr. Magadla, Farmer

*“We rural people, we are sometimes ignorant, but we also want to know things. We also want to be better and see ourselves progress. Until you came here, I did not really think of mobile apps, but now I feel like it is time that I also ‘login’.”*

Mrs. Mavuma, Farmer

Under mandatory conditions the compliance requirement causes social influence to have a direct effect on use; individuals alter their intentions in response to social pressure. However, in a

voluntary context, social influence is just one of several factors that influence perceptions about the technology. The individual will make the final decision based on whether the suggested technology is intrinsically rewarding or the value they place on the recommender's expertise or opinion (Venkatesh et al., 2003)

The analysis conducted in this section produced three main findings. Social influence is only significant as a direct determinant of application uptake when use of the application is mandatory. Under these conditions, social influence causes a change in intention, while under voluntary conditions, it needs to cause a change in the individual's belief structure. Social influence was a more important driver of application uptake for less educated facilitators who were strongly motivated to impress their employer by using the application. The link between social influence and education was conditioned by workplace seniority. Senior facilitators attached less importance to social influence as a driver of application uptake as they delegated much of this work to highly motivated junior facilitators.

#### 4.4.4 Facilitating conditions

There was limited variation in the facilitator's perception of their facilitating conditions and facilitating conditions was found to have no significant direct effect on facilitators' behavioural intention. However, facilitating conditions was found to influence facilitators' behavioural intention as a construct of effort expectancy. Facilitators' perceptions of the level of ease associated with the application were influenced by their perception of the supporting organisational and technical infrastructure. Similarly, the farmers' intentions to use the application was influenced by the degree to which they thought they would be supported.

Facilitators felt that knowing beforehand where they could go if they needed technical help influenced how much effort they associated with using the application. The knowledge that there would be a help when they needed it resulted in their being more confident in their capability to use the application.

*“I am confident using the application because I know whom to consult if I have problems, unlike calling and having the phone being transferred from one person to the next.”*

Ms. Nongogo, Facilitator

Mrs. Mchunu, one of the farmers, shared similar sentiments about having technical support and knowing where to access help. She felt that if the application were introduced to her through Mr. Mathunjwa her facilitator, then at least she would know where to go when things went wrong, and she may consider using it.

*“If the app people were to come with Mathunjwa, maybe I would consider it, because I know that if something goes wrong, I can go to him and say, ‘you told me to do this, look now!’”*

Mrs. Mchunu, Farmer

The level of support required was found to vary with experience amongst both facilitators and farmers; facilitators and farmers with less experience with mobile applications required more hands-on support. Mrs. Njeya was one of the least experienced facilitators; she felt that the technology being used in the application was of a higher degree, and she doubted her capabilities. Having a supervisor who was willing to sit down and work through the application with her encouraged Mrs. Njeya’s use of the application.

*“For a very long time I struggled with it, even my supervisor would sit with me, and we would struggle together.”*

Mrs. Njeya, Facilitator

Mrs. Jili, a farmer who had never used a mobile application before felt that if she had the support of her facilitator she could learn how to use the application. Like Mrs. Njeya, Mrs. Jili required more than knowing there will be technical support of her application use. Her perception of the presence of day-to-day support influenced her feeling capable of using the application.

*"I think if someone were to teach me I would be able to; I am no slow learner. Ms. Mncwabe would teach me."*

Mrs. Jili, Farmer

The cases of Mrs. Njeya and Mrs. Jili introduce the importance of relationships in mobile application adoption. Mrs. Njeya and Mrs. Jili both had an accessible manager or facilitator whom they felt they could rely on to support their application use. Lima's agricultural manager felt the Mpumalanga province was performing poorly in terms of application use compared to KwaZulu-Natal and the Eastern Cape, and they cited differences in management styles as a possible reason.

*"I think it is more due to a lack of management capacity than a lack of ability of the facilitators to use the app. You do need a strong understanding of what you are trying to do with the database, and that needs to translate down to the people on the field. Otherwise, you are going to get the Lephalale and Mpumalanga cases where we battle with data, and the outstanding data is generally from those sites. ...you know there are tools that you can use to rectify problems, there is Skype, there is TeamViewer, there are so many applications that are available today. Just like you and I right now, if you were a staff member of mine, you could just say I do not understand this and this, and we can sort it out through Skype, we could share screens, send WhatsApp and talk about it. It is communication and management that is key to success for the transfer of data in mobile applications."*

KwaZulu-Natal Agricultural Manager

A managerial difference between the three provinces was indeed observed. The Eastern Cape and KwaZulu-Natal managers left it to the researcher and facilitators to make interview and visit arrangements, while the Mpumalanga manager coordinated the interviews and gave the researcher specific times to call each facilitator. The Mpumalanga manager's behaviour was indicative of someone who likes control and who closely supervises their subordinates. One would expect this close monitoring to encourage the Mpumalanga facilitators to use the application more to improve their perceived performance. Data shows that this is true, as two of

the top three application users are from the Mpumalanga province. Mpumalanga being a high performing province appears to be in contrast with the agricultural manager's observation.

There is a possible explanation for the variation in observation. The manager complained not about the quantity of data from Mpumalanga, but rather its timeous availability. Given the lag between application use and data transfer, factors other than the facilitators' use of the application could be at play. The weak network signal could well be one of these factors.

Facilitators in the Mpumalanga region and some areas of the Eastern Cape reported having connectivity problems. The connectivity issue was raised during the beta phase of the application, and the developers made adjustments such that the application had offline functionality. However, whatever data the facilitators collect remains on the tablet until the device is online, only then can the data be uploaded onto the Reporter. In areas plagued by frequent network problems, such as Bushbuckridge, this can be a serious issue. The facilitator in Bushbuckridge complained about the network in their area. Even holding the telephone interview proved a challenge as the signal was weak. This network problem could potentially explain why someone like Mr. Maja who - on paper - should be a high-level user, is not one.

Consistent with UTAUT modelling, the study found that facilitating conditions had no direct influence on the behavioural intention for facilitators. However, a direct link was observed for farmers. This difference may stem from the extent to which farmers rely on Lima and the depth of the relationship between farmers and facilitators. The farmers have seen how their enterprises have changed since the intervention of Lima. Most have already adopted best-practice methods of production and have reaped the rewards. Whatever habits or reservations they have can be influenced by the belief that their facilitator will be beside them, helping, and this encourages a shift in their belief structure. The mid-term evaluation of the Programme (Williams, 2018, p. 34) highlights and criticises farmer reliance on Lima.

*“Many farmers wanted Lima to facilitate the operation and management of their co-ops, as they felt they needed an independent entity in order to run things effectively. The general perspective was that Lima would take the lead and farmers would follow. Farmers trust Lima*

*and hold them in high regard, but often view them as essential to their day-to-day operations and want them to be involved in the finer details, rather than just having them on call to assist when an issue is beyond their knowledge scope or experience. This indicates a heavy dependence on Lima and the role they play in implementing the FSP as an extension programme, which further alludes to the negative consequences if Lima were to exit a site.”*

This kind of reliance and dependency does not exist in the contexts that the UTAUT model was based on and this may explain the difference. This study found facilitating conditions to influence facilitators’ behavioural intention as a construct of effort expectancy. Facilitators related their perceived organisational support, and conditions of their sites, such as unreliable electricity and network services, to how much effort it would take to use the application. Facilitating conditions was found to influence facilitators’ use of the application directly; this relationship was moderated by experience with applications in general and the facilitator’s work site. Facilitators in areas with unreliable network and electricity supply struggled to upload data onto the Reporter timeously. The relationship between facilitating conditions and the behavioural intention of farmers was found to be influenced by experience with applications in general. Farmers with more experience using mobile applications required less user support and found facilitating conditions less important when forming their intentions to use the proposed application.

#### 4.4.5 Other factors influencing behavioural intention

In addition to the factors and relationships theorised in UTAUT, this study identified other factors and interactions that influenced farmers’ behavioural intentions. These factors could shed further light on ways of promoting farmer uptake of the proposed application. The identified factors are peer recommendation, trust, habit, investment priority, farming scale and enterprise.

##### *Peer recommendation*

Many farmers commented that their intention to use an application would be influenced by recommendations from peers and by observing it used by someone they know and trust.

*"If I were to see someone else I know using it, someone I trust, then I would be more inclined to use it."*

Mrs. Ntuli, Farmer

Peer recommendation plays a vital role in this farming community, and not only concerning technology adoption.

*"At some point, the pump broke, we had it repaired, and it was working well. Then it broke again, that is when we stopped. Then, the other farmers like Mr. Vili told us that we should plant either amadumbe, sweet potato or anything else that does not need constant watering."*

Mrs. Qwathekana, Farmer

A wealth of farmer networks exists in most of the areas studied. Through these networks, information is disseminated, advice is given, and belief structures are altered. Most smallholders can, and do, consult leading farmers in their area for advice. These farmers wield considerable influence as smallholders follow their advice.

*"I do not just do things. As I said, I have a mentor. He is very accessible. I usually call him when I have questions, so I would first ask what he thinks. He has experience and distributes his produce nationally."*

Mr. Chonco, Farmer

These networks and influential farmers will no doubt play a key role in farmer adoption of the proposed application.

Although peer recommendation is closely associated with social influence, they are different factors. Strictly speaking, social influence is the belief that it is important to other people that you behave in a particular way. Peer recommendation, on the other hand, is founded in knowledge sharing, and the recommender is typically not invested in the other farmer's choice. In this case, the decision to use the recommended system is based on the farmer's belief rather than coercion, and he or she is, therefore, more likely to keep using the system (Rose et al., 2016).



Based on these findings, this study recommends that the proposed application should first be introduced to farmers whose opinions are valued by the smallholders in their areas. The application being recommended to the smallholders by influential farmers could improve the adoption of the proposed application.

### *Trust*

Many farmers stated that the level of trust they have in the source of the application would influence their decision to use it. Farmers were eager to use an application associated with Lima as it is a brand they trust and one that has presence and visibility in their communities. Farmers had also seen improvements in their enterprises since their affiliation with Lima.

*“Maybe if it were to be recommended by people I trust, like the Lima people, I would use it.”*

Mrs. Ntuli, Farmer

*“I think I would accept anything from Lima because we are not as knowledgeable in what we are doing ... Right now, I would definitely trust Lima more because my knowledge is limited, and I have seen results from them.”*

Mr. Zondo, Farmer

Trust becomes particularly important if the proposed application is intended to support farmers' decision-making. Safety, confidentiality, reliability, and relevance of the information provided are crucial. In this study, farmers were particularly concerned about the risk associated with online activity.

*“If the app people were to come with Mathunjwa, then I would have some trust in them, but if they came by themselves, I would be more sceptical. You may show me the app, just to trick me and get my information. Lots of people are full of tricks. However, I trust Mathunjwa; I know that he would not bring the wrong people to me.”*

Mrs. Mchunu, Farmer

Mrs. Mchunu trusts Mr. Mathunjwa, her facilitator. The two have established a relationship based on Mr. Mathunjwa's long-term, enthusiastic and regular contact with her and the farmers in her cooperative. This study identified that relationships between facilitators and farmers were integral to agricultural extension success. In most cases, the facilitators are the farmers' main source of farming information. To the farmers, they are the face of agricultural knowledge. The Mid-Term Report (Williams, 2018, p. 33) quoted a farmer saying, "We do not even know who our Department of Agriculture extension officer is – we have never seen him. We only know Lima".

To the farmers, the facilitators are the face of Lima, the organisation. In some cases, the trust that the farmers have in Lima is an extension of the trust they have in the facilitators with whom they have established a relationship. Indeed, some of the farmers interviewed in this study did not recognise Lima as an organisation, referring only to Lima's local facilitator. When members of the cooperative in Wembezi, Estcourt, were asked what Lima does for them, one of the farmers said "nothing," and then went on to list what their local Lima facilitator had done for them.

Facilitators recognised the importance of building relationships with their clients. They stated that it made introducing new technologies easier. Relationships were an important factor when the application was introduced, particularly as facilitators had to ask farmers to register and sign on tablets instead of paper. Despite some anxiety associated with this new technology, it was accepted by farmers as they were working with people they trusted who guided them through the process.

*"As long as you are someone the farmers regularly see, and you explain to them why there has been a change, especially where things need to be signed. Farmers do not like signing things they do not know. It has a lot to do with relationship building. As long as you have shown yourself to be someone who strives to work with the farmers, they are receptive of what you are asking of them. If you do not have a good relationship with farmers, they will never sign for you, because farmers get told not to give out their ID numbers to people and a lot of our stuff requires ID numbers for verification purposes. Farmers would not give out their ID number to*

*someone who only arrives once in a while. I arrived here in March 2017, but I still have to explain myself to some people, to let them know who I am and that I have taken over from the person they are accustomed to because they have retired. I have to say who I am, where I am from and explain that the previous person is no longer working. I need to approach them with a big smile, even if I have problems at home.”*

Ms. Nongogo, Facilitator

This study found that farmers show strong trust in Lima, its facilitators and managers. This trust is built through relationships based on long-term and regular contact with supportive facilitators. Application developers need to develop and trial new applications with trusted facilitators who can recommend the application to the farmers they serve. The facilitators can test the application for value to user and relevance, and in the process, build capacity to provide support to users.

#### *Investment priorities*

Many smallholders are resource-poor; they worry about making ends meet and saving enough to afford an important asset. For many of them, applications are a luxury that will have no significant impact on their bottom line. Many of the farmers interviewed in this study digressed during the interview to share the challenges they face, which they saw as more pressing than an application that helped them with bookkeeping.

*“Look, if I may deviate just a bit, I am the Chairperson of the Farmers’ Association of the whole district. I hear their pleas and cries in all the different sectors of farming, like the beef, the potato, the wool growers, and so forth. The government helps certain sectors, but when you look at the sea industry and the white meat industry, there is really not much assistance. The sector is growing very slow for me. On the wholesale stage, yes, I can see progress, but when we look at the primary level, it is very challenging.”*

Mr. Armstrong, Farmer

*“Our electricity has not been working since December. We lost chickens because of it and have not been able to produce since. Even with the sewing, we have a pile of orders for school uniforms but cannot work because we have no electricity. ”*

Mrs. Mchunu, Farmer

*“...small stock is really bothering my bananas now that they have started fruiting, I do not have the money for a fence.”*

Mrs. Qwathekana, Farmer

Farmers are more likely to adopt an application if their basic needs have been satisfied. Interventions that address these pressing needs will make farming applications more relevant as tools to improve farmer livelihoods.

#### *Habit*

Rose et al. (2016) found that habits were a significant factor affecting farmers’ use of decision support systems, particularly amongst older farmers. A similar pattern was observed in this study. Older farmers were generally more set in their ways and reluctant to adopt new systems. For instance, Mrs. Jili, when asked whether she would ever adopt a mobile application as a decision support tool, replied:

*“I feel like I already know what I have to do on my crops, the department of agriculture came here and showed us.”*

Mrs. Jili, Farmer (66)

Due to the involuntariness of application use for the facilitators, the effects of habit were difficult to observe amongst them. However, the cases of Mr. Madikizela and Mr. Mathunjwa emphasise the challenge posed by habits even when a new system is mandatory. These facilitators were so comfortable with doing things a certain way that they delegated the task of using the new system to their support staff even though colleagues spoke positively of its effectiveness.

### *Farming scale*

Scale of production was not included in the original UTAUT model but is important in a smallholder setting. For smallholders, the cost of new technology often outweighs its benefits as they produce small quantities of output. In this study, scale was found not to be a significant moderator of performance expectancy. This finding may be due to the very low cost to farmers of registering and participating in the new system, and to the lack of variation in the scale of observed farming operations. The latter reason is important because one of the application's main functions is input planning but very few of Lima's clients keep records of input use as their expenditure on purchased inputs is trivial. Many estimate their input spend and rely on memory rather than documentation (Williams, 2018). Large farmers with accurate information stand to benefit more from the application than small farmers, and this may well limit the uptake of Lima's proposed application as the cost of time and effort required to use this application will shift from Lima's facilitators to the farmers themselves.

### *Farming enterprise*

This variable has to do with scale and information demands of enterprises that farmers undertake. The study found that farmers engaged in land intensive, non-traditional, and higher risk enterprises were more likely to adopt the proposed application.

*“Yes, I would definitely have more use for it with the chickens, because they are something that I am not as knowledgeable about and the challenges there are much greater than on the piggery side.”*

Mr. Armstrong, Farmer

Developers should pay attention to enterprises such as poultry and pigs that can be produced at scale despite small farm areas. They must ensure that there is adequate relevant information on these enterprises because they can improve the profitability of smallholders' operations despite the challenge of limited access to land.

Another good strategy for encouraging application adoption amongst the smallholders would be to create an application catering to the issues they are already interested in addressing but do not know how to. This study found that smallholders, like Mr. Dlamini, are interested in expanding their operations but often lack access to relevant information. Developing, and introducing effective mobile applications could alleviate this challenge.

*“Yes, even now I have spoken to my headman about raising goats, I have identified a good area for it, and there is a market for goats. Now I do not know where I could go to find information on where to find a good breed for my conditions and information on what to do if they were to get sick.”*

Mr. Dlamini, Farmer

#### 4.5 Summary of findings

The study found that the UTAUT model was, with some minor modifications, an appropriate model to guide this study of mobile application uptake by small-scale farmers in South Africa. Many of the observed relationships between key determinants, moderating factors, behavioural intention, and use behaviour were consistent with the Model’s theoretical propositions. Figure 4.1 presents the key factors that were found to influence Lima facilitators’ intention and use behaviour. Blue arrows indicate direct causation, while orange arrows indicate moderating effects

This study found that the distance of a facilitator’s site from the head office did not affect the application’s level of use. Location effects were more strongly linked to the reliability of local electricity supply and network services, and access to local markets. Being older did not reduce the levels of application use.

On the contrary, older facilitators made greater use of the application. Levels of use differed between males and females, with the females displaying higher levels of application use. Better educated facilitators made greater use of the application than their less educated peers. Levels of use were not influenced by experience with the application in question, or by experience with

mobile applications in general. It is important to note that the UTAUT model does not consider these attributes to be direct determinants of intention and use. The attributes influence the direct determinants of use and their observed effect on use is the result of their interaction with the direct determinants.

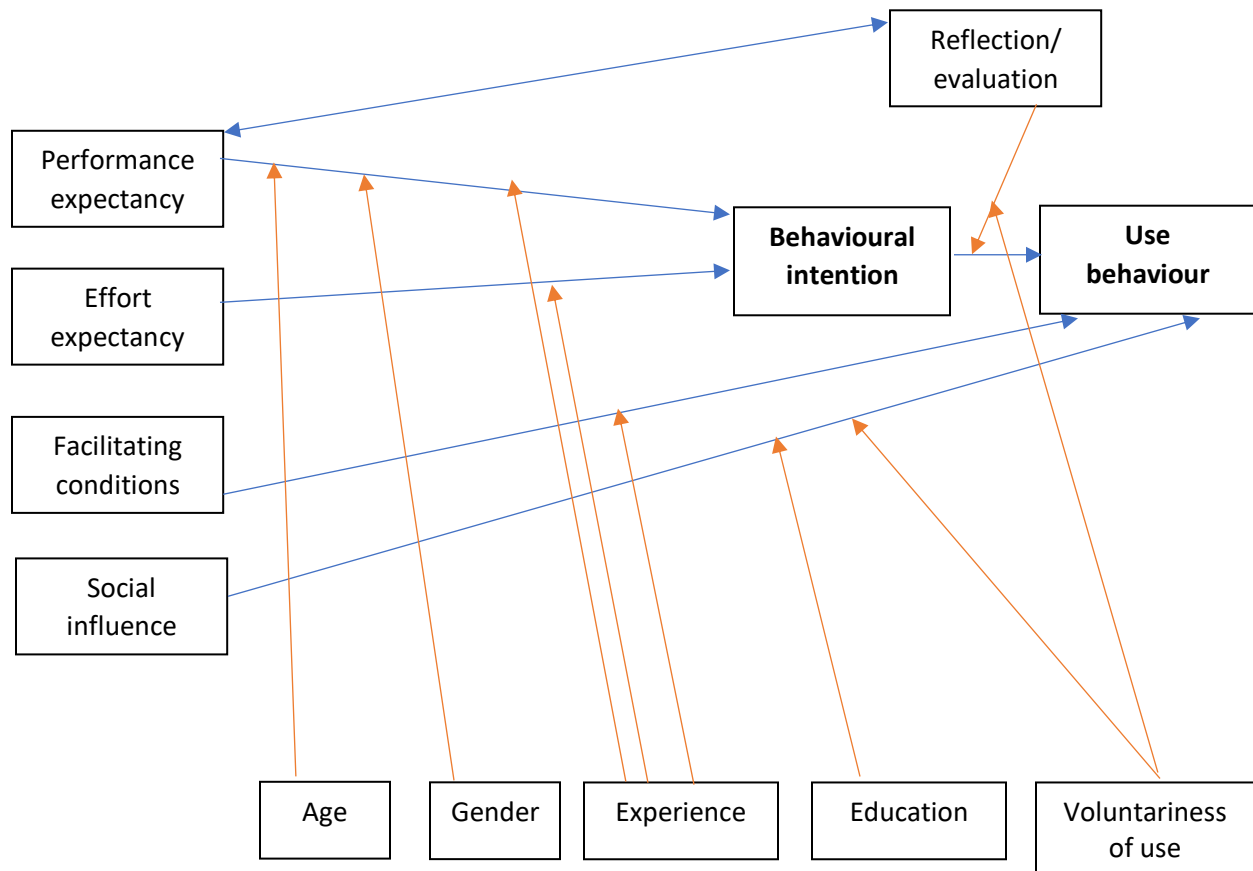


Figure 4.1 Key factors influencing facilitators' behavioural intention and use behaviour

The UTAUT model treats performance expectancy, effort expectancy, social influence and facilitating conditions as the direct determinants of intention and use. Performance expectancy was found to be a direct determinant of behavioural intention, moderated by gender. The effects of gender were found to diminish with age, and this may be related to the decreasing gender gap in ICT experience amongst the younger generation. Gender is expected to matter less as gendered access to ICTs decreases. This study also found that initial performance expectancy may inform user intention, but it is subject to review and feedback which may affect the level of

use even when use is compulsory. Under voluntary conditions, performance expectancy was found to have a greater impact on use and could result in discontinued use.

Effort expectancy was found to be a direct determinant of intention to use the application, and its effect was found to be more pronounced in older women, particularly under voluntary use conditions. General experience with mobile applications moderated the influence of effort expectancy on intention to use, such that facilitators with more experience attached less importance to effort expectancy when establishing their intentions to use the application. Social influence was found to be a direct determinant of use under mandatory conditions. This relationship was moderated by education; less educated facilitators had a greater incentive to impress their employers through enthusiastic use of the application.

Figure 4.2 presents the key factors that were found to influence intention and use behaviour amongst the facilitators' smallholder clients. Under voluntary conditions, social influence directly affected behavioural intention, but not actual use. Farmers who witnessed other individuals using and benefiting from a new application were more likely to review the application and establish performance and effort expectations for it. Actual use, however, requires a favourable assessment. Facilitating conditions were found to influence use by facilitators directly and to influence the behavioural intentions of farmers. The effect of facilitating conditions on behavioural intention and use was found to be moderated by experience with mobile applications in general.

Beyond the determinants of application use proposed by the UTAUT model, this study identified peer recommendations, trust, and habits as determinants of farmers' intentions to use mobile applications. Relationships between the farmer and facilitator influenced actual application use. Moderating factors that were expected to further influence farmers' performance expectancy included farming scale and enterprise. The farming scale was found to have no significant moderating effect on performance. However, due to the farm planning functionality of the proposed application, relatively larger farmers who keep accurate records stand to gain more



from the application. The study found that farmers engaged in land intensive, non-traditional, and higher risk enterprises were more likely to adopt the proposed application.

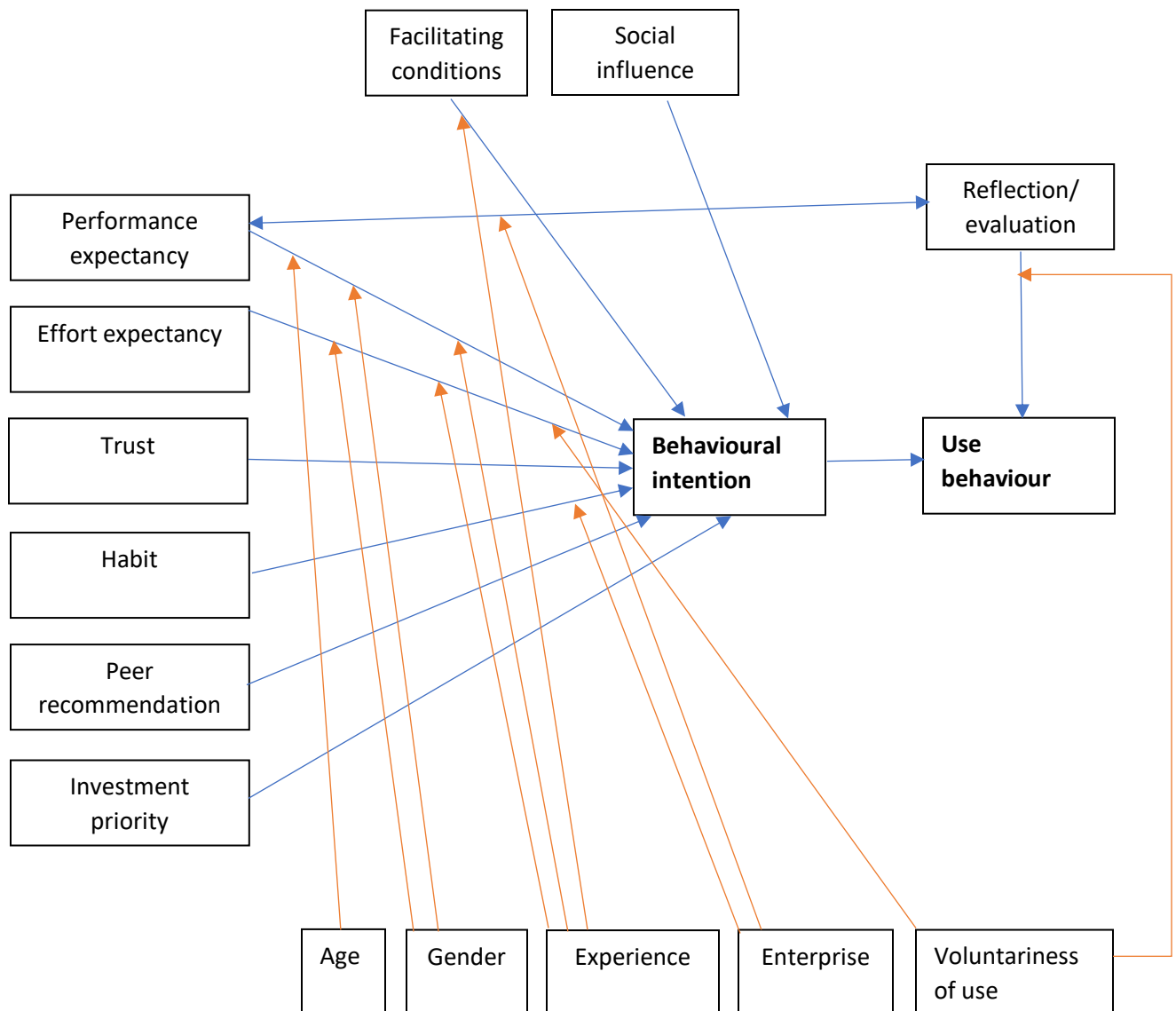


Figure 4.2 Key factors influencing farmers' behavioural intention and use behaviour

## 5 Conclusion

### 5.1 Introduction

This thesis had the aim of answering the research question: how can mobile applications aid participatory extension? To answer this question, this study targeted four objectives, namely, (1) to determine what factors influenced the adoption of the Lima Farmer Support Application; (2) to determine whether levels of use differed between users, and what features of the application were most commonly used and why; (3) to identify characteristics that distinguished high-level users from lower level users of the application, and (4) to establish what infrastructure facilitated use of the application. The study drew on the Unified Theory of Acceptance and Use of Technology (UTAUT) model developed by Venkatesh et al. (2003) to inform propositions about factors influencing adoption of the application and the attributes and use-behaviours of the adopters.

This study was deemed relevant because of the vital role agricultural development is expected to play in the quest to reduce poverty and unemployment in South Africa. This development requires effective agricultural extension services, and mobile applications have the potential to contribute to making extension delivery more efficient. This study employed a qualitative single case study of the Lima Farmer Support application. Facilitators, their farmer clients, managers and application developers were interviewed to gather data for the study and were treated as individual units of analysis. Matched pairs sampling was employed for farmer and facilitator respondents to help control for characteristics expected to influence application use. Propositions derived from the UTAUT model (presented in Chapter 2) were tested against the data using a 'pattern matching' approach.

The remainder of this chapter synthesises key findings of the study and the recommendations relating to its objectives and research question. It concludes with the study's contribution to the literature, its limitations, and recommendations for future research.

## 5.2 Key findings

The first objective was to determine what factors influenced the adoption of the Lima Farmer Support application. This study proposed that the expected performance of the application would have a major influence on the adoption of the application. The findings matched the proposition. Performance expectancy was found to be an important factor for both farmers and facilitators when establishing intentions to use the application.

The study also identified a link between performance expectancy and actual use. It was established that users reviewed the performance of the application after the intention to adopt had been formed, and they adjusted application use based on this revision. Social influence and facilitating conditions contributed to facilitator adoption and use behaviour. Facilitating conditions were also important to farmers. Trust and investment priorities, in particular, were emphasised by farmers as being important in forming their decision to adopt a future version of Lima's application intended for use by master farmers. Other factors that contributed to farmers' intention to adopt included enterprise type, farming scale and peer recommendations.

The second objective was to determine whether levels of use differed between users, and what features of the application were most commonly used and why. It was anticipated that levels of application use would differ between facilitators, that functions perceived as being more useful would get more use, and that the use would be demand-driven. The findings were broadly in line with these propositions. Levels of use differed between facilitators depending on their education, experience, and - to some extent - their work site. Use of the different application functions was demand-driven, with the workers' registration function least in demand. While usefulness influenced the demand, so did ease of use. Facilitators deemed the workers' registration function less user-friendly as it was prone to glitches and this further discouraged its use.

The third objective was to identify characteristics that distinguished high-level users from lower level users of the application. The intention was to help Lima select master farmers most likely to be high-level users of their proposed application. The study found that facilitators who were older, more educated and female showed higher levels of application use. However, amongst the

farmers, younger males expressed greater interest in using the proposed application. The findings concurred with the view that gender, education, age, and experience do not have a strong direct influence on adoption, but instead condition other factors that impact adoption. Two attributes stood out as highly influential; the type of farming enterprise for farmers, and experience with mobile applications in general for both farmers and facilitators. Farmers pursuing land-intensive farming enterprises were more eager to adopt the proposed application than those engaged in less intensive enterprises. General experience with mobile applications had the greatest perceived effect on behavioural intention to use Lima's applications.

The final objective was to establish what infrastructure facilitated the use of the application. It was proposed that facilitators working in areas with better access to organisational and technical infrastructure would display higher levels of use. The study found that facilitators' level of application use was affected by a lack of reliable network and electricity supply in some locations. It was also found that awareness of quality technical and organisational support for users reduced facilitators' effort expectancy and encouraged adoption. Farmers' intention to use the proposed application was also positively influenced by the knowledge that their facilitators would provide training and user support. The study found that farmers had close bonds with their facilitators, they trusted them, and they trusted Lima, the NGO that employed them. The trust that was built through long term relationships and Lima's ongoing presence in their communities was an important factor in their decision to adopt the proposed application. Farmers were eager to find new markets to improve their incomes and their ability to finance productive assets. The study found that securing markets for farmers was important for the adoption of the application.

Drawing on these findings, it was concluded that mobile applications can support participatory extension when: the mobile application provides relevant services and actionable advice to farmers; the application is introduced by a reputable organisation as part of an intervention that links farmers to markets; extension staff that have prior experience with mobile applications, in general, is used; and when farmers selected to be master farmers have prior experience with mobile applications and are engaged in land-intensive farming enterprises.

## 5.3 Recommendations

This section presents recommendations based on the findings reported in Sections 4.2, 4.3 and 4.4. The recommendations are directed at policymakers, application developers, Lima, and other NGOs and agribusinesses to improve the adoption and efficiency of mobile applications for participatory extension. Although the recommendations are directed largely at the Lima Farmer Support Application and the imminent Lima Master Farmer Application, most are also relevant to other extension applications in South Africa.

### 5.3.1 Factors influencing adoption

Performance expectancy and facilitating conditions were found to be important factors for both farmers and facilitators when establishing intentions to use the applications. Social influence was found to be an important factor for facilitators as their use of the application was mandatory. For farmers, peer recommendation was more important than social influence. This study recommends that application developers should focus on features that have high levels of usability and relevance. The development of the application should be demand-driven and should involve end-users to ensure relevance and compatibility with user conditions. The application should have functions that offer demonstrable value to farmers in order to make participation worth their effort. If the application offers advice, that advice must be actionable and expressed in terms that farmer clients understand. For example, smallholders have little use for quantities measured in tons as they do not produce at that scale. The application should rather use local measures such as 50kg bags. The application should operate fast, have a simple design, and allow for quick correction of errors. Lima facilitators complained of having to start afresh to correct a mistake, that some functions would ‘hang’ once initiated, and that certain tasks had too many paths. The developers should debug the application regularly to improve its performance, include an ‘undo’ function to correct errors, and reduce the number of taps and cross-application navigation required to complete specific tasks. It is also recommended that the application should include a search function on its profile pages and dropdown lists to reduce fat finger errors and save navigation time.

Regarding facilitating conditions, it is recommended that agricultural extension applications should be introduced by an organisation with a trusted name using facilitators, mentors or extension officers that have a long-standing relationship with the farmers. Along with trust, peer recommendation played an important role in farmers' intention to use the application. It is therefore recommended that applications should first be introduced to enthusiastic farmers who have influence within their communities. Applications should be introduced gradually, either through advancing from a computer to a mobile application, as was the case with the Lima application or by introducing the application piecemeal, starting with the simpler functions. The gradual introduction of the Lima application was found to improve experience and bolster confidence amongst users.

This study also recommends that agricultural extension applications be introduced as part of a broader initiative aimed at linking farmers to markets. Farmers struggled to see the benefits of an application as they felt that they had more pressing issues such as securing markets and acquiring productive assets. This result suggests that applications should be introduced to support initiatives that encourage farmers to invest in value addition. The e-Choupal model in India and the Farmers' Hubs Agri-Marketing Enterprise (FHAME) in Bangladesh are good examples of such ICT-integrated initiatives (Shalendra, Gummalgolmath, & Sharma, 2011; Syngenta Foundation for Sustainable Agriculture Bangladesh, 2019). E-Choupal is part of a private sector initiative that offers alternative markets for smallholder products and inputs and provides information on weather and agricultural practices. It operates from a kiosk in a village, is equipped with a computer and internet access and is managed by a trained lead farmer (Shalendra et al., 2011). FHAME uses a centralised facility, the farmers' hub, as an aggregator for input-buying and output sales, as well as a provider of agricultural information and machinery rental services. The hubs are commercially managed under the franchise business model, with the Syngenta Foundation for Sustainable Agriculture (SFSA) Bangladesh as the concept-holder of the model and franchisor. SFSA Bangladesh monitors quality and provides support to franchisees. The hubs' total business management system is digitally maintained by a mobile application and web dashboard platform called e-Hub. E-Hub also provides agricultural information to farmers through SMS (SFSA Bangladesh, 2019). Both e-Choupal and FHAME have been successful

initiatives. E-Choupal has won numerous awards, including the United Nations Industrial Development Organisation Award for exemplary initiatives in agribusiness, while an independent impact assessment of FHAME showed that farmers associated with the hubs enjoyed a 25% increased yield and a 34% increased income between 2018 and 2019 (ITC Limited, n.d; SFSA Bangladesh, 2019).

This study revealed that site specific facilitating conditions such as erratic power supply and unstable cellphone signal, influence effort expectancy and therefore affect behavioural intention. This issue can be addressed in two ways. Firstly, through policy that encourages mobile communications companies to extend and improve their networks in rural South Africa. Secondly, and more attainable in the short run, developers need to design the application with the inadequacies of South Africa's rural infrastructure in mind. In particular, the application must be able to function offline, temporarily storing data that can be uploaded once the user has internet access via mobile data or Wi-Fi.

### 5.3.2 User attributes

The study found that facilitators who were older, more educated and female made greater use of Lima's current application. However, amongst the farmers, younger males expressed greater interest in using Lima's proposed application. These user attributes tend to influence other factors that determine use. Experience was the only attribute with an unambiguous effect on the direct determinants of application use. Both farmers and facilitators that had prior experience using mobile applications (of any sort) showed greater interest in using Lima's applications. Farming scale and enterprise type had a direct influence on farmers' intention to adopt the proposed application – larger farmers engaged land-intensive enterprises were found to be the most likely users of the application. General experience with mobile applications should, therefore, be a selection requirement for new facilitators and master farmers. This study also recommends that farmers involved in land-intensive enterprises should be preferred when selecting master farmers. Land-intensive enterprises help to mitigate the constraining effects of small farm size on the farming scale. Observing these farmers using the application should

encourage use by other farmers as peer recommendation was found to be an important determinant of its adoption.

#### 5.4 Study's contribution, limitations, and future research

This study contributes to literature by identifying factors that influence the adoption of Lima's Farmer Support application and by generating rich information on the relationships between user attributes, application characteristics, facilitating conditions, and application use. The study also generates evidence-based recommendations to encourage the use of Lima's current application and to improve the design and development of Lima's proposed master farmer application. Although not generalisable to all agricultural extension applications, many of the recommendations are relevant to applications with an agricultural focus within a smallholder context.

The findings and corresponding recommendations also highlight a need for strategies that integrate ICTs into the extension component of broader agricultural interventions. A key limitation of this study was the small number of facilitators available to sample. This small sample constrained the number of pairs that could be identified to control for factors other than those under scrutiny. Validity was also affected by the lag between the time facilitators were interviewed and the time that they started using the application, as their responses may have been affected by imperfect recall. Furthermore, farmers' responses to the proposed master farmer application were based on their perception of the application used by their facilitators, rather than knowledge of the application that was being developed for master farmers. The researcher also had limited understanding of the current application's functions prior to data collection. This influenced the objectives of the study and may have compromised the richness of the data.

Going forward, research should be conducted into whether the introduction of the master farmer application actually improves efficiency in the delivery of extension services. This research will require baseline data on farm and farmer characteristics, and one or more follow-up surveys to record changes observed amongst both adopters and non-adopters. This research could provide



useful evidence on the impact of ICT-enabled participatory extension services and the returns to investments made in their mobile applications.

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## Appendices

### **Appendix 1: Outline of the interview topics that were used to conduct the semi-structured interviews for facilitators**

#### **1. Application demand**

- a. Source of idea
- b. Consultation
- c. Necessity of the application

#### **2. Factors influencing adoption**

- a. Determinants of behavioural intention
- b. Effects of voluntariness of use

#### **3. Facilitating conditions**

- a. Infrastructure or services
- b. Support structures
- c. Suggestions

#### **4. Application use**

- a. Ease of use
- b. Application properties (screen properties, required add ins, network connectivity, etc.)
- c. Usefulness
- d. Most used functions

#### **5. Farmer relations**

- a. Number of farmer-clients
- b. Acceptance by farmers
- c. Possible master farmer use

## **Appendix 2: Outline of the interview topics that were used to conduct the semi-structured interviews for farmers**

### **1. Secondary use**

- a. Transition from old system
- b. Factors influencing use
- c. Most useful functions on facilitator application

### **2. Attributes**

- a. Farming scale
- b. Enterprise
- c. Market access

### **3. Proposed mobile application**

- a. Knowledge of mobile applications
- b. Interest in mobile applications in general
- c. Lima master farmer application
- d. Factors influencing intention

## Appendix 3: Consent form

### CONSENT FORM FOR INTERVIEWS

**Project title: Mobile applications as a tool for participatory extension: A case study of Lima farmer support application**

Please tick the appropriate boxes	Yes	No
<b><i>Taking Part</i></b>		
I have read and understood the project information sheet dated DD/MM/YYYY.		
I have been given the opportunity to ask questions about the project.		
I agree to take part in the project. Taking part in the project will include being interviewed and recorded (audio)		
I understand that my taking part is voluntary; I can withdraw from the study at any time and I do not have to give any reasons for why I no longer want to take part.		
<b><i>Use of the information I provide for this project only</i></b>		
I understand my personal details such as phone number and address will not be revealed to people outside the project.		
I understand that my words may be quoted in publications, reports, web pages, and other research outputs.		
<b><i>Please choose one of the following two options:</i></b>		
I would like my real name used in the above		
I would <b>not</b> like my real name to be used in the above.		
<b><i>Use of the information I provide beyond this project</i></b>		
I agree for the data I provide to be archived at Lincoln University Library		
I understand that other genuine researchers will have access to this data only if they agree to preserve the confidentiality of the information as requested in this form.		
I understand that other genuine researchers may use my words in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form.		

Name of participant..... Signature ..... Date .....

Researcher ..... Signature ..... Date.....